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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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International Standards.

We are all familiar with the way in which national specifications are formulated. At some point in the development of an industry the market in a particular material becomes great enough to cause manufacturing users to feel that they cannot rely entirely on the uniformity of material as between different suppliers. They endeavour to formulate a statement respecting its desirable properties, and then leave it to suppliers to adopt any method of manufacture they please provided these requirements are met. In the first place, therefore, specifications are formulated by private agreement between manufacturing users and their suppliers. Frequently such independent parties as consulting engineers may issue specifications on behalf of their own clients, and ultimately a condition is reached in which a multiplicity of specifications exist for a given material. This is found by suppliers to militate against regular production, since they now have to meet a multitude of slightly varying requirements. Specifications may therefore become standardised for a whole trade, through the various trade associations, and ultimately it is found necessary to put them on a national basis. At this point the British Engineering Standards Association invites the mutual co-operation of users and suppliers and ultimately a national specification results. The value of these specifications to British trade, always unquestionable, is now unquestioned, and incidentally we regard the organisation of the B.E.S.A. as admirably adapted to its purpose. Opinions have been expressed that the American Society for Testing Materials has advantages over the B.E.S.A., inasmuch as it promotes a good deal of the research required in the course of specification work. There is in our minds no doubt whatever of the enormous superiority of the British method, by which the B.E.S.A. is divorced from the usual functions and responsibilities of a technical or scientific society, and is thus able to maintain indisputable impartiality. There is no reason why B.E.S.A. co-operators should not arrange for any work required in the course of formulating specifications to be done through their respective institutions.

The necessity for international specifications has been recognised for many years, but in 1914 the good work done by the International Association for Testing Materials was abruptly terminated. Proposals are on foot to restart the work thus interrupted, and the question arises as to the encouragement founders should afford to it. The attitude of founders as a whole is sufficiently shown by the fact that quite independently they have during the past few years established a skeleton international organisation for dealing with tests, testing procedure and specifications, and a remarkable measure of unanimity has already been achieved. While we do not believe that any attempt should be made to merge this activity in the new efforts on the broader basis to be discussed shortly in Amsterdam, we think that the founding industry would be well advised to take part in the proceedings, if armed only with a watching brief.

It may be argued that there is an insufficient international trade in cast iron to warrant any such interest, but the matter must be looked at from the broader point of view. Only by the use of common tests and methods of testing procedure can foundrymen in different countries correlate their practical experiences, and only by such international co-operation can the foundry metallurgist and the foundry manager solve the more baffling of their problems.

The Institute of Metals.

MEETING IN DERBY.

Metals in Modern Transport.

Dr. L. Aitchison, of Birmingham, gave the opening lecture of the annual meeting at Derby last Tuesday, under the chairmanship of Sir John Dewrance, K.B.E., president of the Institute.

Dr. Aitchison said that the reasons for the employment of the non-ferrous metals in our various systems of transport are very similar to those that govern their utilisation in all other branches of engineering. The non-ferrous metals and alloys are only needed when they can offer certain chemical or physical properties that are required by the engineer and that are not possessed by iron and steel. In general, the properties that lead to the greatest employment of the non-ferrous metals and alloys are:—(1) A high resistance to corrosion; (2) high values of thermal or electrical conductivity; and (3) a low value of specific gravity. In addition, the properties of ease of machining, ease of cold working and simplicity of casting contribute to the wider usefulness of the materials.

The use of non-ferrous metals on account of high electrical or high thermal conductivity is particularly illustrated by the purposes to which copper is put. This metal enters very extensively into the construction of electrical plant, whilst its thermal conductivity is made use of in boiler tubes and the like.

A high resistance to corrosion is a conspicuous feature of nickel and its alloys. These metals are not very extensively used in connection with transport systems, but a fairly prominent example of this service is found in cupro-nickel condenser tubes. Many examples of good resistance to corrosion are found in the alloys of copper. Typical illustrations of the use of this metal and its alloys on this account occur in condenser tubes and turbine blading, as well as in gunmetal and phosphor-bronze castings, which are extensively employed in ship construction.

The use of metals having a much lower specific gravity than iron and steel, and having at the same time mechanical properties which are comparable with those of the ferrous metals, is of great importance in transport systems. The alloys that are actually employed are those based upon aluminium and magnesium. The alloys of aluminium at the present time are, of course, much more extensively employed than the alloys of magnesium, and the aluminium materials find their way into a great many parts, both in the cast and in the wrought condition. A variety of aluminium casting alloys can be employed, and are more or less interchangeable, but the majority of the wrought parts are made in duralumin. The way in which weight saving can be achieved by the adoption of light alloys, is illustrated in the lecture by reference to the method of construction of rail coaches and food containers, and to their use in constructing panels and structural sections in tramcars, motor cars and motor 'buses. In addition, aluminium alloys are extensively used for a large number of castings that are incorporated in automobile engines, whilst in the wrought state they serve admirably in a number of engine parts and in the structure of the vehicle.

An important branch of modern transport is that comprised by aeroplanes, seaplanes, flying-boats and airships, and in all these branches of transport, lightness is a property which is prized very greatly. The employment of the non-ferrous metals in these different forms of aeronautical structure, as well as in the engines that are employed to drive them, afford very interesting examples of the value to the engineer of the low specific gravity of the light aluminium alloys—these being one-third of those of the irons and steels.

Another field into which non-ferrous metals enter very largely is that of anti-friction materials. These are of various kinds, having tin, or lead, or copper as their basis. They are able to function in a way that no steel or iron is able to rival.

Yesterday and this morning Papers were read of which the following are abstracts.

"The Under-Cooling of Some Aluminium Alloys," by Marie L. V. Gayler, D.Sc.

The effect of under-cooling on the macro- and microstructure of some silicon-aluminium and copper-aluminium alloys has been studied. It has been found impossible to under-cool "modified" silicon-aluminium alloys systematically, and it has been shown that the curves of solubility represented by the "modified" diagram correspond closely to the supersolubility curves of the "normal" alloys.

"The Constitution of Alloys of Aluminium with Silicon and Iron," by A. G. C. Gwyer, B.Sc., Ph.D., and H. W. L. Phillips, B.A., A.I.C.

The first part of this investigation deals with the constitution of binary alloys of aluminium with silicon and with iron. The eutectiferous nature of the aluminium-silicon system has been confirmed, and special attention paid to the solubility of silicon in solid aluminium. The position of the Al-$FeAl_3$ eutectic has been re-determined, and the structure of the alloys lying towards the middle of the constitutional diagram has been, it is thought, elucidated.

The second part deals with the constitution of certain of the ternary alloys of aluminium, silicon and iron, under both equilibrium and metastable conditions. The latter are of considerable practical importance, because they are met with not only in commercial alloys, but also in commercially pure aluminium.

"The Equilibrium Diagram of Copper-Tin Alloys containing from 10 to 25 Atomic per cent. of Tin," by A. R. Raper, B.A.

This investigation on the copper-tin alloys forms a continuation of the work done by Stockdale on this system. The alloys have been examined both by thermal and micrographic analysis, and the results obtained have confirmed in many respects the classical work of Roberts-Austen and Heycock and Neville.

The $\alpha + \beta = \beta$ boundary has been carefully determined micrographically. This boundary shows a sudden change in direction at 580 deg., which, together with other micrographic evidence, favours Stockdale's view of a polymorphic change of the β constituent.

The eutectoid point has been found to be at Sn 16.15 (or 73.15 per cent. Cu by weight), the temperature of the inversion being 520 deg.

The "transformation" curve has been determined carefully by thermal analysis, and the results are entirely in agreement with those of Roberts-Austen and Stansfield. In particular, the slight horizontal indicated by them at about 610 deg. has been confirmed. As determined by the present author, it exists from Sn 22.5 to Sn 25 at a temperature of 638 deg. The inclusion of this new horizontal in the diagram makes the interpretation of this region easier, and evidence for a new eutectoid at Sn 23 has been obtained.

"Effect of Work and Annealing on the Lead-Tin Eutectic," by F. Hargreaves, A.R.S.M.

A marked softening action of work at air temperature on the lead-tin eutectic is found, and the effect of different degrees of working is investigated. In the case of 78 per cent. reduction in thickness, the Brinell hardness is reduced from about 14 in the chill-cast condition to 4.2 when tested immediately after hammering. This value is actually lower than that of either constituent in the pure state. Annealing at air temperature and at 100 deg. C. for different periods is carried out, and the effect on the rate and extent of recovery in hardness determined. Finally, the

effect of annealing at just below the melting point is recorded. Little micrographic work is recorded. Reference is made to the relationship of well-known phenomena to the results obtained.

"Researches on Intermetallic Compounds. VI.—The Reaction Between Solid Magnesium and Liquid Tin," by William Hume-Rothery, M.A., Ph.D.

The reaction between solid magnesium and liquid tin has been studied between 250 and 350 deg. C. in order to see whether reactions of the type

Primary solid X + liquid = secondary solid Y

can proceed when the solid phases concerned do not form solid solutions.

When a rod of magnesium is stood in a limited quantity of molten tin, the magnesium dissolves until the liquid reaches the equilibrium composition at the particular temperature concerned. Since, however, true equilibrium requires the compound Mg_2Sn (probably Mg_4Sn_2) as the phase in equilibrium with the liquid, a further reaction of the type

Solid magnesium + liquid = solid magnesium stannide

tends to take place, and the above point can be tested, since no solid solutions are formed.

The experiments show that when sufficient magnesium has dissolved to give the liquid the equilibrium composition, all further direct reaction is stopped by a thin film of magnesium stannide which shows no appreciable thickening even after three weeks at the above temperatures. On the other hand, a few large crystals of magnesium stannide are sometimes formed by a slow reaction. This is probably the ordinary phenomenon of crystal growth due to surface energy effects, since the thin surface film has a high surface energy and so tends to form a more compact mass. But any solution at one point exposes more magnesium to the action of the liquid, and so the reaction gradually proceeds.

The experiments are regarded as of interest in connection with the fundamental principles underlying soldering and other reactions between solid and liquid metals.

"The Copper-Magnesium Alloys, Part II." by W. T. Cook, B.Sc., and W. R. D. Jones, M.Sc.

This report deals with an investigation of the forging of copper-magnesium alloys, and is a continuation of that given on the casting of these alloys and the mechanical properties of chill-cast bars. The properties of the alloys in the forged and heat-treated conditions have been determined and examined. The ductility of these alloys depends, primarily, on the forging temperature. If this temperature be low the elongation and the reduction of area are impaired seriously, and the values are not restored by subsequent heat-treatment. The mechanical properties of copper-magnesium alloys containing up to 11 per cent. copper are not improved by simple heat-treatment, which causes a general decrease in test values. The addition of copper to magnesium up to about 2 per cent. is beneficial. Beyond this amount the increase in tenacity is small, whilst there is a regular decrease in ductility and a proportional increase in specific gravity. There is no advantage in adding more than this amount of copper to magnesium either for castings or for forgings. To obtain the best results the forging temperature must be controlled, and care must be taken to guard against any possibility of cold-shut when casting ingots for forging.

"Grain Growth in Compressed Metal Powder," by C. J. Smithells, D.Sc., W. R. Pitkin, and J. W. Avery, B.Sc.

The changes which take place in certain properties of bars of pressed tungsten powder when the temperature is gradually raised have been investigated. These changes are attributed to grain growth, which is shown to begin at a temperature determined by the particle size of the powder and the pressure used in forming the bar. Using powders whose mean particle size varied from 0.6 to 3.5 μ, and pressures between 8 and 32 tons per sq. in., the temperature at which grain growth could first be detected varied from 1,100 K. to 1,500 deg. K. These conditions cover those usually employed in the technical preparation of ductile tungsten. The results are in conflict with those of Sauerwald, who was unable to detect grain growth below 2,800 deg. K., but are consistent with the established facts of grain growth in worked metals.

"The Constitution and Physical Properties of Some of the Alloys of Copper, Zinc and Cadmium," by C. H. M. Jenkins, B.Sc., A.R.S.M.

The constitution of the copper-zinc-cadmium alloys has been studied, and the physical properties of the two most commonly used brasses containing small proportions of cadmium investigated.

The study shows a complex constitution in the range of the ternary system where the copper content exceeds 45 per cent. and the cadmium content is less than 10 per cent. The solid solubility of cadmium in α brass diminishes with increasing proportions of zinc from a maximum value of 2.7 per cent. Cadmium present beyond the proportion retained in solid solution is found to occur as the binary constituent, Cu_2Cd. The alloys whose constituents are α brass and more than a trace of Cu_2Cd commence to melt at comparatively low temperatures between 549 and 614 deg. C. Traces of free Cu_2Cd on heating dissolve in the α phase without melting, owing to the slightly increased solubility at higher temperatures.

A peritectic reaction, in which the β phase of the Cu-Zn system reacts with liquid to form the α phase and Cu_2Cd, occurs in this system at 614 deg. C., considerably affecting the properties of the alloys. This reaction is primarily due to the result of the two peritectic reactions found in the binary copper-zinc and copper-cadmium alloys, at 906 and 549 deg. C. respectively.

The effect of cadmium on β brass is noticeable in a different manner. This phase shows a greatly increased solid solubility for cadmium with increase of temperature reaching a maximum value at 8 per cent. At low temperatures the γ constituent appears to have a greater power than the β phase of retaining cadmium in solid solution.

The effect of cadmium on the physical properties of 70:30 and 60:40 brass has been studied by the use of cadmium-bearing zinc containing proportions of cadmium decidedly in excess of those likely to be encountered in retort zinc. The results show that the greater proportion of the cadmium content of the zinc is retained in the brass and is not lost by oxidation or volatilisation during melting. The presence of less than 0.2 per cent. of cadmium seems to prevent the hot-rolling of 70:30 brass and cadmium, and of more than 0.5 per cent., to increase to a slight extent the liability to unsoundness in cast material.

The general results indicate that the use of cadmium-bearing zinc does not produce any marked alteration in the physical properties of the brass. Additions of cadmium up to 1 per cent. by weight cause an improvement in the tensile strength, generally accompanied by a reduction in elongation. The effect is most noticeable in the cast 70:30 brass, and is less pronounced in worked material.

"The Protection of Aluminium and Its Alloys Against Corrosion," by H. Sutton, M.Sc., and A. J. Sidery.

Some experiments are described in which samples of aluminium and aluminium alloys were treated by various protective processes, including anodic oxidation, zinc-, cadmium-, and nickel-plating. Certain practical features of the methods investigated and, also, the results of corrosion tests extending over periods of 1 to 2 years, are discussed. The resistance of aluminium, Duralumin, and of certain other aluminium alloys to corrosion by sea-water is considerably increased by anodic oxidation and the subsequent application of a grease, such as lanoline.

Electro-deposited coatings of zinc, 0.0005 in. thick, afforded better protection to aluminium than did coatings of cadmium of similar thick-

XUM

ness, but the two types of deposit appeared to give an approximately equal degree of protection when applied to alloys of aluminium. Unsatisfactory results were obtained from nickel deposits of normal thickness. Comparison is made between anodic oxidation and zinc- or cadmium-plating as methods of protecting aluminium or aluminium alloy parts of aircraft.

"The Nature of the Film Produced by Anodic Oxidation of Aluminium," by H. Sutton, M.Sc., and J. W. W. Willstrop, B.Sc.

A method of isolating the film from anodically-treated aluminium is described. The metallic aluminium is volatilised in dry hydrogen chloride. The properties of the film so obtained are described, and the thicknesses of films obtained under various conditions have been calculated. The films isolated from treated commercial aluminium sheet are usually of a grey colour, due to traces of carbon left behind when the aluminium sublimes as chloride. The presence of elementary silicon in films produced on commercial aluminium is also shown. Films varying in thickness from 0.033 μ to 2 μ have been obtained, the thickness of the film produced by the usual standard treatment being about 1 μ. From the volume of gas evolved by treated aluminium when heated *in vacuo* to 1,200 deg. C. the film is shown to consist of oxide and not of hydroxide.

"Age-Hardening Tests With Elektron Alloys," by K. L. Meissner, Dr. Ing. (Berlin-Charlottenburg).

Six different Elektron alloys made up by the I.G. Farbenindustrie A.G. at Bitterfeld (Germany), were examined with respect to their capability of age-hardening by ageing at room temperature and at elevated temperatures up to 200 deg. C. with different ageing periods of from 8 to 40 hours.

"The System Magnesium-Cadmium," by Wm. Hume-Rothery, M.A., Ph.D., and S. W. Rowell, B.A.

The equilibrium diagram of the system magnesium-cadmium has been investigated by thermal and microscopic methods. The system is shown to contain a solid solution based on cadmium and denoted α, a definite intermetallic compound $MgCd_2$, and a solid solution in magnesium denoted β. The solid solution α extends from 0 to about 24 atomic per cent. magnesium at most temperatures. The compound $MgCd_2$ does not form any solid solutions, whilst the β solid solution extends from about 40 to 100 atomic per cent. magnesium.

The solidus and liquidus are shown not to meet at the composition 50 atomic per cent. as reported by the earlier workers. The β solid solution undergoes a transformation at temperatures about 200 to 250 deg. C., but the maximum temperature of this change is at 54 atomic per cent., and not at 50 atomic per cent. as previously reported. This change is unaccompanied by any alteration in microstructure, and it has not been possible to obtain any two-phase alloys in this region either by slow cooling or by quenching. It is suggested that the change is of the same nature as that of the β brasses.

It has been shown that prolonged annealing is necessary to attain equilibrium in the solid alloys in the neighbourhood of the compound $MgCd_2$, and the principal differences between the present and the earlier work are due to the fact that the former investigators did not anneal their alloys for a sufficient time.

"Note on Cathodic Disintegration as a Method of Etching Specimens for Metallography," by Cyril S. Smith, B.Sc., D.Sc.

The well-known phenomenon of cathodic sputtering can be used to develop the structure of metal specimens for microscopic examination. Silver-copper alloys are particularly suited for etching by this process, which causes staining of the copper-rich constituent as well as removal of the silver.

Founding in Tudor Days as Revealed by Testamentary Evidence.

By H. LITTLEHALES.

Amongst the great number of wills made by English citizens 400 years ago may be found a certain number made by ironfounders. In these at times one meets with curious and interesting details which throw a light on the business of ironfounding in Tudor days.

These wills tell us how many workmen were employed by the master, their names, and in a measure how he regarded them, and how a founder's widow gave a small sum to every poor parish by whom her husband had been employed to cast bells. They tell us of the tools used, the appraiser's valuation of the stock, something of the furniture and home of each testator and many other details. The London wills are in big registers generally in very beautiful writing.

These details can be found amongst the wills at Somerset House, whilst others were published many years ago by the Surtees Society. The medieval founder worked in iron, lead, copper, brass and pewter. Sometimes he managed a little business almost alone, at other times he had several workmen in his employ. A substantial part of the business was that of bell founding.

In his work he used the lathe, staples, rings, nails, iron bolts of various sizes, anvils and moulds. A good deal of timber was kept in stock for pattern making and a number of patterns were on the premises, yet oddly enough though the number of patterns is often given, and is considerable, yet in no instance is there anything like the quantity one would expect bequeathed or set down in inventories.

That which we call the foundry proper to-day was known centuries ago by the expressive names of either "The Melting House" or "The Workhouse." A small founder in the north of England having in 1492 three apprentices left a part of his working stock to be divided between them, but not in equal proportions; this distinction between the apprentices was probably made by the deceased founder, by reason of each having been bound to him at a different time or having done better service. To each, however, a portion of the testator's "wirkyng irons" were given that they might "continue the craft."

Another founder making his will in the year 1493 left to his "servant," that is one of his workmen, whose name was William Richardson, his "hak hammers" and lathe hammers (a somewhat strange name) and "clense" hammers, his "grater," files, knives, burnishers' (one of which was two handled) and all the tools in his "shope."

To another "servant" he leaves all the tools "in the melting house" and to a friend, a Mr. Wynder, who was a pewterer, he leaves a "weybalk of Iron" with the scales belonging to it. This weybalk was probably a great beam running across the melting house for weighing. It would need to be a strong one, for weights of more than 1,000 lbs. were in use in the medieval foundry.

Sand was then known as "earth." This was of three different kinds—white, plain, and "made," that is made up ready for use. White earth was delivered at the foundry in barrels, plain earth by the load.

The medieval "melting house" contained whetstones, pincers, grindstones, spades, shovels, weights (of both metal and stone), charcoal, tongs, mortars and pestles, stools, tubs, sieves, "maunds" or baskets, "erth" or sand boards, crucibles, pails (of wood), "greate and small" files, hammers of many sizes, clamps, lavors, "rowners" (whatever they may have been), compasses, picks, hooks, and the indispensable shears.

There would, of course, be metal of various kinds in the form of sows, pigs, and rough broken stuff, as to-day. Amongst other articles forming part of the equipment of a foundry 400 years ago were "cooling troughs," which appear to have been generally in the form of casks or barrels.

Air-Furnace Practice.

By Christian Kluijtmans, B.Sc., M.A.T.F.

(*Continued from page* 198.

Oxidation of Constituents.

The constituents partly lost during melting are silicon, manganese and carbon. These losses are due to the different reactions taking place during the melting, and vary with the working of the furnace. At the beginning of the process oxidation is very weak, but gradually increases as the temperature rises and the iron melts. The greatest oxidation takes place when the metal starts to melt, owing to the globules of metal offering a great surface to the combustion gas and the excess of air. As soon as the charge is melted the oxidation decreases as the combustion gas is merely playing upon the surface of the bath, which is protected by the slag.

The slag is the product of the oxidation of the iron, silicon and manganese, the carbon being expelled through the stack mainly as CO. It is a double silicate of iron and manganese. In practice the ratio of oxidation is 25 to 30 per cent. for the silicon; 50 to 60 per cent. for the manganese, and 12 to 15 per cent. for the total carbon. It is thought that the iron is oxidised in the ratio of its atomic weight. Examining the different losses, it is seen that they are proportional to the atomic weights of each constituent.

	Atomic weight.	Loss. Per cent.	Average.
C. ..	12	12 to 15	13.50
Si. ..	28	25 to 30	27.50
Mn. ..	55	50 to 60	55.00

This is not always true, and can be considerably disturbed according to the working of the furnace. It has been found, however, that when the total carbon was high, the oxidation of silicon was proportionately less, thus:—

	Calculated composition.	Composition obtained.	Loss. Per cent.
C. ..	3.40	2.80	22
Si. ..	1.20	0.90	25
Mn. ..	0.55	0.25	54.5

With a lower carbon content the result was:—

	Calculated composition.	Composition obtained.	Loss. Per cent.
C. ..	3.15	2.70	14.2
Si. ..	1.20	0.80	33
Mn. ..	0.55	0.20	63.6

In another hand the author has noted that when the carbon content is very low, the metal obtained is decidedly on the "high side," although the silicon and manganese were high, thus:—

	Calculated composition.	Composition obtained.	Loss. Per cent.
C. ..	3.00	2.00	33
Si. ..	1.30	0.55	57
Mn. ..	0.56	0.20	64

The above analyses have been made on the plug taken before addition of spiegel and ferro-silicon, the final analysis being:—T.C., 2.00; Si, 0.85; Mn, 0.28; S, 0.06; and P, 0.19 per cent.

From the above it is seen that the oxidation of carbon seems to be slowed up when reaching 2.80 per cent. to take care of the oxidation of the silicon. In the converter process the order of oxidation is silicon, manganese and finally carbon, which explains why, when making blackheart malleable and utilising this method, the results are unsatisfactory owing to the difficulty of stopping blowing when reaching the correct analysis. Comparing the oxidation of the silicon with the carbon, it is found that: (1) The silicon losses are 25 per cent. with 1.20 Si and 3.40 carbon; (2) they are 33 per cent. with 1.20 Si and 3.15 carbon, and (3) they attain 57 per cent. with 1.30 Si and 3.00 carbon.

The above remarks apply to a furnace working under normal conditions. The manganese must be approximately 0.25 to 0.30 per cent., the extreme limits being 0.20 and 0.40 per cent. The phosphorus must range from 0.15 to 0.22 per cent. The sulphur must be as low as possible and not exceeding 0.10 per cent.

Thickness of Castings.

Although this question belongs to the foundry department, the metallurgist must take it into consideration. On the same floor there may be thickness ranging from $\frac{1}{4}$ in. up to 2 in., either in different or on the same casting. Therefore he will have to calculate the charge accordingly to the thickest of the castings so as to avoid "primary graphite." A good guide is to cast one test bar 10 in. long and 2 in. square. This test bar is not standard and may be varied in dimensions, but it is important, once started, to retain them.

Influence of Constituents on Iron as Cast.

Silicon and carbon are the two main constituents having a marked influence on the iron as cast. The composition sought is the one giving a white iron for a thickness of 2 in. sq. combined with the best properties after annealing. Additionally a Si-C ratio must be established, which, after solidification of the molten metal, is not liable to produce primary graphite. Primary graphite, which is formed during solidification, is detrimental to the strength of the final product, as during annealing it produces small intercrystalline cracks which develop when the casting is put into service. In Table I is set out the Si-C ratios which have proved to give the best results in practice:—

TABLE I.—*C-Si Ratios for Blackheart Malleable.*

C. max.	Si. max.	C. max.	Si. max.
(*a*) 3.10	0.50	(*g*) 2.50	0.80
(*b*) 3.00	0.55	(*h*) 2.40	0.85
(*c*) 2.90	0.60	(*i*) 2.30	0.90
(*d*) 2.80	0.65	(*k*) 2.20	0.95
(*e*) 2.70	0.70	(*l*) 2.10	1.00
(*f*) 2.60	0.75	(*m*) 2.00	1 to 1.30

From the fluidity point of view it has been noted that *a*, *b*, *c* for the same temperature will have the maximum of fluidity, *d*, *e*, *f*, *g* will require higher temperature for the same fluidity as *a*, *b*, *c*. Furthermore, *h*, *i* and *k* will be less fluid for the same temperature. The last two ratios *l* and *m* are called very high heat and possess poor running properties.

From the annealing point of view *a*, *b*, *c* will give normal results, *d*, *e* will show good results, *f* and *g* will have very high tensile strength and elongation, as also will the ratios *h*, *i*, *k*. The ratios *l* and *m*, however, would have to undergo a special annealing.

Influence of Constituents on Annealing.

Carbon.—In white iron it is combined with the iron to form a carbide of iron (Fe_3C), called in practice "combined carbon" and scientifically "cementite."

Silicon.—Has the property of speeding up the decomposition of the carbide or iron into graphite and ferrite with the aid of temperature and time.

Manganese.—Over 0.45 per cent. retards annealing.

Sulphur.—Over 0.10 per cent. retards the annealing.

Phosphorus.—Over 0.25 per cent. produces hard spots and induces warping during annealing.

Practical Remarks on Molten Iron.

The molten iron provides a good guide worthy of study. Three different kinds of iron are seen from time to time.

(1) Fair iron, apparently cold, and moving in the shank like oil, is generally devoid of life. The plug is grey or mottled, the iron being high in carbon and silicon. Such metal is very good for the casting, but will not give good results after annealing, yielding only about 15 tons per sq. in. tensile and 6 per cent. elongation.

(2) Hot iron, full of life, which does not stick to the edge of shank. It gives a white plug, showing good crystalline arrangement. It has the highest fluidity to be associated with an iron of normal composition. It provides a very good iron for casting as well as for annealing. It will give 20 to 23 tons per sq. in. tensile and between 14 to 18 per cent. elongation.

(3) Sluggish iron that is a "high heat" which sticks to the ladle and is apparently dead. It gives a white granular plug, has poor fluidity, whilst the constituents are very low, especially the carbon. This iron makes poor castings, involving a high percentage of short-run castings. It is, however, quite good for annealing.

Melting Practice.

Starting with a heat after a general repair involving a new bottom, which is covered with boards to protect it against the impact of iron during charging, the scrap is charged, first being piled up against the front bridge, then follows the steel, if any, and on top comes the pig-iron. Every piece of iron must be so arranged that little or no space is left between them. This way will give increased space for combustion and ensure a better conductivity of the heat. When the whole of the charge is loaded, the bungs are set in proper place and all cracks or joints are plastered up. The furnace is then fired with straw and wood; when the wood is well burning little coal is shovelled in the fire box, and so on. As soon as the coal is ignited the blast is put on and the heating up of the charge starts.

The coal used should have the following analysis:—Volatile matter, 35; water, 2; ash, 6; fixed carbon, 57, and sulphur, 1 per cent. The analysis of the ash is very important and must indicate a high melting point. Ash having a high percentage of iron, lime and alkalis has a low-melting point and sticks to the grate bars, and therefore should be rejected. If one has to choose between two coals having ash analyses as follows:—

Ash. Per cent.	11 Per cent.	9.30 Per cent.
	1	2
SiO_2 ..	49.30	45.29
Al_2O_3 ..	33.71	31.43
Fe_2O_3 ..	5.60	9.30
CaO ..	2.21	8.10
MgO ..	1.81	1.12
Alkalis ..	2.60	3.82
P_2O_5 ..	1.32	0.57
SO_3	1.80	0.83

Thus coal No. 1 has 11 per cent. of ash against 9.30 for the No. 2, but the fusible matters, such as lime, alkalis and iron, are less in No. 1 coal, 10.41 per cent., as against 21.22 per cent. in No. 2. The melting point for ash of coal No. 1 is higher than the ash of No. 2, although the sulphur content is higher. The calorific power of such coal is about 8,000 to 8,500 calories; it burns with a long, smoky flame.

The melting process can be divided into: (*a*) Heating of the charge up to 1,000 to 1,100 deg. C.; (*b*) softening the iron; (*c*) melting the iron, and (*d*) heating from liquid state up to pouring temperature.

In hand-fired air furnaces the coal is not weighed, but is loaded in the fire box about 5 to 6 minutes. The burning of such coal involves two distinct phases: (1) The volatile matter is burnt by means of top blast, whilst (2) the residual coke requires a bottom blast. The operations between each coal charge are as follows:—

Operations.	Nature of smoke or flame.	Time in seconds.
(*a*) Top and bottom blast shut	No smoke.	4
(*b*) Loading of X shovels of coal	Black smoke.	60
(*c*) Spreading of coal on grate	,, ,,	30
(*d*) Bottom blast $\frac{1}{3}$rd full..	Grey smoke	5
(*e*) Top blast, $\frac{2}{3}$rds full ..	White ,,	5
(*f*) Burning of volatiles..	Red (flame)	120
(*g*) Shaking of grate bars..	,, ,,	30
(*h*) Top and bottom blast shut	No smoke	4
(*i*) Poking of fire ..	Red flame	60
(*j*) Bottom blast $\frac{2}{3}$rds full	,, ,,	4
(*k*) Top blast $\frac{1}{3}$rd full ..	,, ,,	4
(*l*) Shaking of grate bars ..	,, ,,	30
(*m*) Bottom at Top blast shut	No smoke	
		356 seconds

which corresponds to 6 minutes.

The combustion is easy to control by the nature of the smoke or flame. When the coal is in excess the smoke is black and leaks through any small crack in the furnace fabric. When the air is in excess the flame is very short and red and can be seen through the hole of the chimney just above the back bridge or between the space left between, the two bungs being near the stack. The number of coal charges will be about 7 to 9 per hour, the total time of heating being 7 hours.

An excess of coal produces a reducing atmosphere associated with poor combustion, and high losses in CO passing up the stack. This involves both waste of time and coal. An excess of air is detriment to the iron as the atmosphere is very oxidising. Obviously a strict control must be imposed.

Below is given three examples of working between each coal charge, involving (1) reducing; (2) neutral, and (3) oxidising conditions in the furnace.

TABLE II.—*Firing to Give Reducing Conditions.*

Time.	Operations.	Blast.		Time in minutes.			Nature of smoke or flame.
		Bottom.	Top.	R	N	O	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
11.32	17 shovels of coal ..	—	—	—	—	—	Brown
11.33	,,			1	—	—	Black
11.34	,,			1	—	—	,,
11.35	Poking ..			1	—	—	,,
11.36	,,			—	—	1	Red
11.38	Poking ..	3/3		—	—	2	Brown
11.39	19 shovels	—	—	1	—	—	,,
11.40	,,			1	—	—	Black
11.42	,,			2	—	—	,,
11.44	Poking ..			2	—	—	,,
11.45	,,			—	1	—	Brown
11.46	Poking ..	3/3		—	1	—	,,
11.47	,,	3/3		—	1	—	White
11.48	20 shovels	—	—	1	—	—	Black
				10	3	3	

The columns Nos. 5, 6 and 7 show that on a total of 16 minutes 10 minutes are absorbed by a reducing atmosphere, due to excess of coal, against 3 minutes neutral and 3 minutes oxidising, emphasising the importance the way the coal and air are worked between each load.

If this sequence is repeated each time, the heat will be delayed.

Table III shows the normal working of the furnace; that is, good combustion, ensuring rapid melting, normal coal consumption and average oxidation of silicon, carbon and manganese.

Table IV shows that the atmosphere of the furnace was oxidising for 5 min. against 3 min. of neutral conditions. The furnace atmosphere is best when neutral, but slightly oxidising conditions are preferable to reducing. The volume of air should be calculated so that for every 1 lb. of coal but 120 cub. ft. enters the furnace.

As it is seldom easy to regulate the blast, the author constructed a recording device for both bottom and top blast. The apparatus is quite simple, and consists of a strong clock working at

TABLE III.—*Firing to Give Neutral Conditions.*

Time.	Operations.	Blast.		Time in minutes.			Nature of smoke or flame.
		Bottom.	Top.	R	N	O	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
11.56	12 shovels	—	—	—	—	1	Grey
11.57	,,			1	—	—	,,
12.00	Poking ..			—	3	—	,,
12.01	Cleaning			—	1	—	White
12.03	,,			—	—	2	,,
12.04	12 shovels	—	—	—	1	—	Brown
				1	5	3	

the rate of one revolution per 12 hours. The axle of the clockwork is connected to a large disc divided in twelve sections. The apparatus is fixed on the framework of the furnace and behind the handle of sliding air damper. On this handle is fixed a chalk holder, with a spring inside it to

TABLE IV.—*Firing to Give Oxidising Conditions.*

Time.	Operations.	Blast.		Time in minutes.			Nature of smoke or flame.
		Bottom.	Top.	R	N	O	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
12.03	12 shovels	—	—	—	1	—	Brown
12.04	,,		3/3	—	1	—	Red
12.05	,,		3/3	—	—	1	,,
12.06	Poking ..		3/3	—	—	1	,,
12.07	,,	—	—	—	—	1	,,
12.08	Poking ..	3/3		—	—	1	,,
12.09	,,	3/3		—	—	1	,,
12.10	15 shovels	—	—	—	1	—	Black
				0	3	5	

permit the chalk to mark on the disc. As the chalk follows the handle and marks on the revolving disc, it shows exactly hour by hour how much blast has been put on. This record is transferred to the furnace log and filed.

Skimming Off.

The skimming of the slag can be done before tapping or after tapping. Before tapping, that is to say, starting about two hours before, the slag is pushed near the rear bridge with the top blast working at full pressure and allowed to run through the slag hole, which is near the back bridge in the thinnest part of the bath (Fig. 4 on the left). This period of slagging is very oxidising owing to the top blast striking on the surface of the bath. Slagging takes about 1 to 1½ hours, during which time the temperature of the bath rises.

As soon as the slagging is finished a test plug is taken. This is the most important moment of the heat, and from the nature of its fracture the temperature and the fluidity of metal is judged, and steps must be taken immediately either to continue the heat or to tap. Great experience is necessary to "read" a plug, for there are about 150 ways of reading a plug. Primarily the temperature of the iron is noted, of which there are two kinds: (1) Actual or real temperature, which can be recorded by pyrometer, and (2) practical temperature, corresponding to the "life" of iron. The founder is familiar with these, and calls them "cold," "medium," "fair," "hot" and "very hot." In grey iron this is satisfactory, for the fluidity is roughly proportional to the temperature, as the composition of grey iron, chiefly the carbon, always exists under comparable conditions. With white iron, for blackheart, and melted in the air furnace, it is quite different.

Taking, for example, an iron with 0.80 Si and 2.60 per cent. C, poured hot, it will be considered as good iron and will run freely. If, however, for the same temperature the iron has 0.70 Si and 2.10 per cent. C, then it will not be sufficiently fluid. Actually it will be rather sticky. That is to say, *the lower the carbon the higher must be the temperature for the same fluidity;* or, *for the same temperature the fluidity is inversely proportional to the carbon content.*

Taking a Test Plug.

A hand ladle is filled up with lightly-rammed foundry sand. With a wooden peg, 6 in. long by 1¾ in. dia., tapering to 1⅜ in. dia., a cavity is made in the sand. A second hole is made with another peg of 1 in. tapering to ¾ in. With a spoon, lined with fireclay and rivetted to a long rod of iron, molten iron is taken in the deepest part of the bath, usually opposite to the tap hole. When the spoon is hot enough, the metal is taken out and poured in the larger test mould, a second being poured in the smaller hole. A third test is taken out, the spoon laid on the floor, and the temperature noted as well as the nature of the iron. Then a groove mould about 4 ft. long by 1 in. wide is made in the floor sand and the iron is poured in.

Nature of the Iron.—This is as important as the temperature. A dull iron, devoid of life and apparently cold, might be satisfactory if it does not stick to the edge of the spoon. This indicates high carbon and silicon. A fair iron, with a very mobile surface, having a very thin film of oxide disappearing from time to time and not sticking to the edge of the spoon, denotes a good iron ready fr tapping. On the other hand, an iron apparently hot, but sluggish and sticking to the spoon, denotes "high heat." It usually gives off sparks. Initially, the iron will run freely, and will fill the groove made for testing fluidity, but the speed of running will be rather slow.

In the second case the iron will run rather rapidly, but will stop at about 3 ft. 6 in. In the third case the length of running will be scarcely 2 ft., indicating that additions of ferro-silicon are necessary.

Cooling of the Test Plugs.

About five minutes after pouring they are taken from the sand and allowed to cool freely in the air until they are black hot. This takes about seven minutes for the smaller plug. It is then repeatedly quenched in water until it is cold. It is then broken and the nature of fracture is noted, and may be as is shown in Figs. 5 to 17. These fractures have again to be divided in two sections corresponding to two different analyses; for instance, they may be either low silicon with high carbon content or high silicon with low carbon content. It is possible to detect the type of analysis portrayed. Supposing there are two test plugs, and that the area of the grey spots is the same, but in one the grey spots are very wide and not so numerous, while in the second plug they are very finely divided. It is thus established that in the first plug the carbon is high and silicon low, while in the second the carbon is lower and the silicon higher. (These fractures are associated with the soft heats and are shown in Figs. 5 to 9.) This is satisfactory for a certain range of carbon which is between 2.80 to 2.60 per cent. and silicon 0.65 to 0.80 per cent., but it is not applicable for carbon content under 2.60, as generally all plugs are white. In normal working conditions the fractures corresponding to Figs. 10 to 14 are the most frequent, and are to be associated with normal heats. The fractures shown in Figs. 15 to 17 are from "high heats." The first small plug broken should indicate that the fracture is the normal one to be associated with the temperature and the fluidity. If not, the large plug will be broken, and steps indicated in Table V should be taken.

The fracture shown in Fig. 17 usually indicates a badly-burnt heat, and very seldom it is possible to recover the whole of the iron, but the following procedure is suggested:—

When Cold.—Additions of ferro-silicon, spiegel and coke should be made, but in this case there is very little chance of saving the heat.

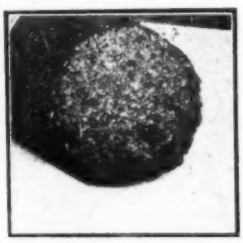
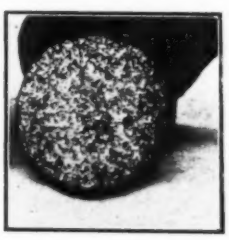
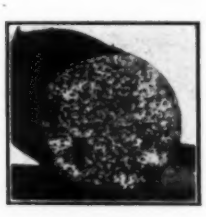
Showing Medium Heat.—This case is slightly better owing to the higher temperature. The same remedy is applied—that is, the addition of ferro-silicon, spiegel and coke, associated with good firing.

A Fair Heat on the Metal.—In this case there may be a fair chance of saving the heat. Ferro-

silicon, spiegel and coke additions will do much if combined with good and strong firing.

Hot Metal.—Although the heat is not out of danger, there is a real chance of saving it. On top of ferro-silicon, spiegel and coke additions one should add high-silicon pig-iron. This will not only cool down the bath, but will also bring up the silicon and carbon content. This method

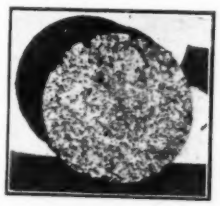
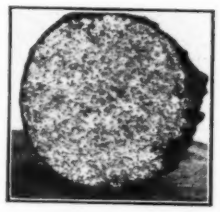
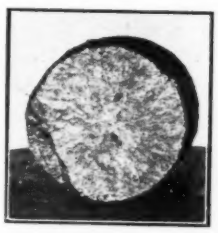
TABLE V.—*TEMPERATURES, FRACTURES AND PROCEDURE.*

Nature of Plug.	COLD.	MEDIUM.	FAIR.	HOT.	VERY HOT.
 FIG. 5.	Continue Firing and take another plug. Revise the	Continue Firing and take another plug. charge and weighing.	Continue Firing and take another plug. check the	Add a little steel. Fire little longer, take another plug and tap.	Add steel, take another test plug and tap.
FIG. 6.	Continue Firing and take another plug.	Continue Firing and take another plug.	Continue Firing and take another plug.	Continue Firing and take another plug.	Add little steel, take another plug and tap.
FIG. 7.	Same as above.	Same as above.	Same as above.	Same as above.	Same as above.
FIG. 8	Same as above.	Same as above.	Same as above.	Get ready for tapping.	Tap. Soft heat.
 FIG. 9.	Same as above.	Same as above.	Same as above.	Same as above.	Same as above.
 FIG. 10	Same as above.	Same as above.	Same as above.	Same as above.	Same as above.

will delay tapping for about one hour. We could not do this way with cold, medium and fair bath, because the whole bath would have been freezing.

Very Hot Metal.—In spite of the temperature, one cannot tap immediately, because the later casts would be sluggish. The only way to overcome the difficulty is to doctor the heat, as indicated above. Another suggestion is to tap and

TABLE V.—*TEMPERATURES, FRACTURES AND PROCEDURE.*

Nature of Plug.	COLD.	MEDIUM.	FAIR.	HOT.	VERY HOT.
 FIG. 11.	Continue Firing, take another plug 30 minutes later. If plug is white, add 30 kos. Fe.-Si.	Continue Firing, take another plug 30 minutes later. If plug is white, add 30 kos. Fe.-Si.	Continue Firing, take another plug 20 minutes later. If plug is white and iron hot, get ready for tapping.	Continue Firing and get ready for tapping.	Tap.
 FIG. 12.	Same as above.	Same as above.	Same as above.	Same as above.	Same as above.
 FIG. 13.	Add 150 kos. Fe.-Si. and 60 kos. spiegel, take another plug. High heat.	Add 100 kos. Fe.-Si and 50 kos. spiegel, take another plug. High heat.	Add 80 kos. Fe.-Si., 40 kos. spiegel, take another plug. High heat.	Add 40 kos. Fe.-Si.,20 kos. spiegel and tap. Slightly high heat.	Tap. Normal.
FIG. 14.	Same as above. High heat.	Same as above. High heat.	Same as above. High heat.	Same as above. High heat.	Same as above.
FIG. 15.	Add 200 kos. of Fe.-Si., 100 kos. of spiegel, take another plug. Fairly high heat.	Add 150 kos. Fe.-Si., 80 kos. of spiegel, take another plug. High heat.	Add 100 kos. Fe.-Si., 60 kos. spiegel, take another plug. High heat.	Add 80 kos. Fe.-Si., 40 kos. spiegel, take another plug. High heat.	Add 40 kos. Fe.-Si., 20 kos. spiegel and tap immediately. Slightly high heat.
FIG. 16.	Same as above. Very high heat.	Same as above. Fairly high heat.	Same as above. High heat.	Same as above. High heat.	Same as above. High heat.

add a few pieces of ferro-silicon in the hand shanks. The reaction taking place heats up the molten iron sufficiently to pour in the mould.

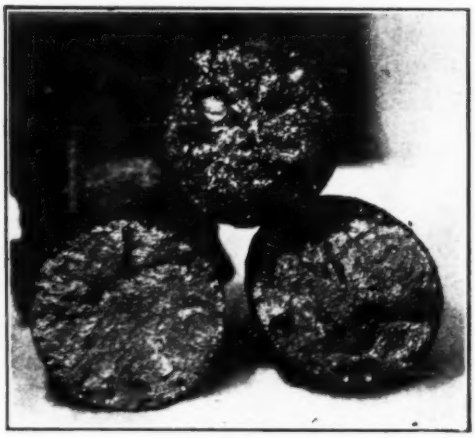


FIG. 17.

Tapping Blackheart Malleable.

Tapping.—Before tapping the following tools must be ready:—Four pieces of wood about 10 ft. long and 2½ in. dia.; two lumps of wet fireclay, having the consistency of dough; four long rods of iron, about 10 ft. long, ¾ in. dia.; four smaller rods, 5 ft. × ¾ in. dia., sharply pointed at one end, and ten small pointed rods, 3 ft. × ½ in. dia. A tank containing water and fireclay, and buckets

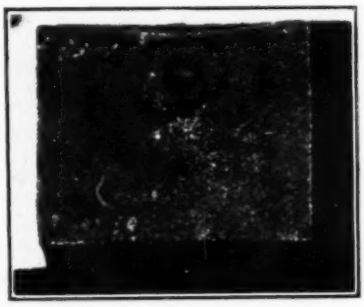


FIG. 18.—BAR FROM A VERY SOFT HEAT.

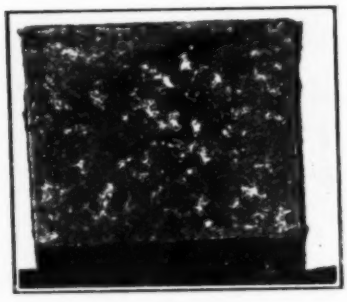


FIG. 19.—BAR FROM A SOFT HEAT.

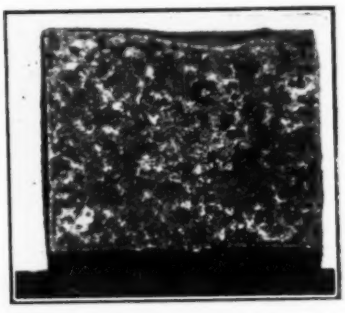


FIG. 20.—BAR FROM A SOFT HEAT.

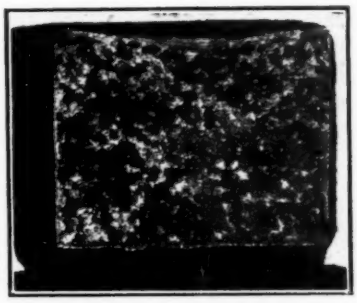


FIG. 21.—BAR BEGINNING TO GET HARDER.

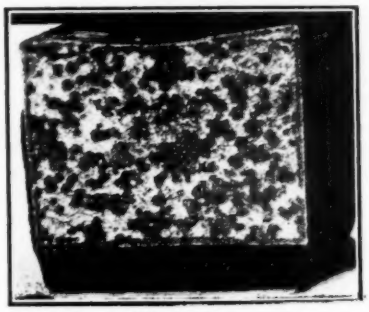


FIG. 22.—IS HARDER, BUT STILL TOO SOFT.

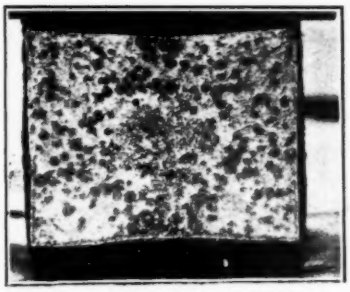


FIG. 23.—AN ALMOST NORMAL BAR.

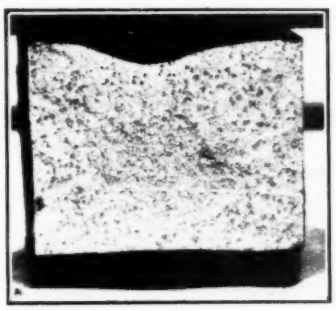


FIG. 24.—THIS BAR SHOWS A NORMAL FRACTURE

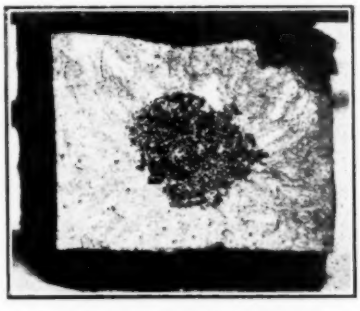


FIG. 25.—SHOWS A SLIGHTLY HIGH HEAT.

of water in case of splashes, should also be handy.

These being ready, the furnace man starts tapping by removing the sand plugging the tap hole carefully until he sees a dull red point at the bottom of the hole, then taking a thin pointed rod, with a good push he gets through the remaining sand; next, without losing time, he pushes the rod up and down in the hole, and takes it out, the rod being followed by the molten iron. Speed is essential, as the rod may stick in the hole and plug it. Usually a few test bars are poured either for the laboratory or for clients. As a rule the laboratory requires six small bars for tensile testing, two square bars for analysis, and one larger bar for control.

These bars are poured as follow:—

Beginning of the heat: Two small bars and one square bar for analysis.

Middle of the heat: Two small bars and a large bar for control.

End of the heat: Two small bars and one square bar for analysis.

Additionally a few wedge test bars are poured about in the middle of the heat.

The large bars are 10 in. long and 2 in. square. They are allowed to cool in the mould and broken the next day. They are more for the furnace man than for the metallurgist. Every morning one-half is taken to the laboratory, the other half being handed to the furnace man, who retains it in a special rack.

These show at a glance the working of the furnace for the week. The different types of fractures obtained through several heats are shown in Figs. 18 to 25.

Accidents.

In every foundry minor accidents to plant occur daily, but they can be largely eliminated by a competent staff and a strict control of all material, machines and tools. In a malleable foundry they are more frequent than in a grey-iron foundry, and it is thought desirable to outline a few typical cases.

Tap Hole.—At the end of the heat after the residual slag has run out a bar, the size of the tap hole, is introduced inside it to keep the passage clear. This bar will be kept straight by means of another rod across the back of the first rod and resting on the sides of the spout. The next morning the bottom around the tap hole will be cleaned and fettled, and the tap hole plugged up with a mixture of two parts of red sand to one part of fireclay. This does not bake too hard, and can be easily broken up when tapping. If the plug bakes hard in the tap hole, it will be difficult to break through, and this may seriously delay the tapping, with its consequent ill effect on the charge, especially when it is on the high side.

Bungs.—A common accident is the falling of bricks in the bath from the bungs. Sometimes the furnace man is at fault by not exercising sufficient care, as, for instance, using them when the bolts are loose. At other times the fault must be ascribed to the quality of the bricks. It is still difficult to find a firebrick which will withstand the heat without cracking. It is much better to have a brick which melts evenly, though they may possess a lower melting point than is specified on the order, than bricks which spall. When a brick is cracked in a bung, it loosens the rest, and the whole fall into the bath. As soon as a bung is thus damaged it is best to replace it as quickly as possible by means of the crane. During replacement, the blast is cut off, and no coal is charged. The time for this operation is about five minutes, but unfortunately it is sufficient to cool and oxidise the bath slightly.

Bar Grates.—It sometimes happens that a bar or several bars are burnt and fall in the ash pit. If this happens at the beginning of the heating up there is only the loss of time in replacing them, but if it occurs just after taking the first test plug, that is about 30 minutes before tapping, this accident may have serious consequences on the final result of the heat. In such a case it is best—no matter what condition the heat is in—to add 100 kilos of ferro-silicon and replace the bars as quickly as possible.

For this, the firebox is emptied, the ash-pit plate is lifted, the whole of the ashes removed and the pit flooded with water. Next a man, suitably protected against the heat, enters the pit, being kept cool by means of a water jet. New grate bars are brought near the furnace and are introduced in the firebox. Happily, this accident happens very rarely, and the author has seen it twice in four years' time, during which period 1,000 heats were made. The first time he had four bars down about one hour before tapping, which delayed tapping for about two hours.

Front Bridge.—After a certain number of heats the whole front bridge must be rebuilt. If this is not done, the liquid iron may eat through the brickwork and fall in the firebox. Every three or four months the brickwork must be made up.

Chimney.—The lining of the chimney must be fettled every month.

The American Institute of Metals.

The following Papers are to read before the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers which is to hold a convention at the Book-Cadillac Hotel, Detroit, September 20 to 22, in conjunction with the annual convention and exposition of the American Society for Steel Treating:—

COMMERCIAL FORMS AND APPLICATIONS OF ALUMINIUM AND ALUMINIUM ALLOYS, by P. V. Faragher.

PRINCIPLES COVERING THE HEAT TREATMENT OF ALUMINIUM, by H. H. Richardson.

MACHINING ALUMINIUM, by R. L. Templin.

SOME ASPECTS OF THE COMMERCIAL MANIPULATION OF ALUMINIUM, by C. F. Nagel, Junr.

PHYSICAL CHARACTERISTICS OF COMMERCIAL COPPER-ZINC ALLOYS, by W. H. Bassett and C. H. Davis.

NICKEL AND MONEL METAL, by C. A. Crawford.

WROUGHT ZINC, by C. S. Trewin.

EQUILIBRIUM RELATIONS IN ALUMINIUM-SILICON AND ALUMINIUM IRON-SILICON ALLOYS OF HIGH PURITY, by E. H. Dix, Junr. and A. C. Heath.

HEAT TREATMENT OF ALUMINIUM-SILICON ALLOYS, by R. S. Archer, L. W. Kempf and D. B. Hobbs.

THE CONDITION OF THE THORIUM CONTENT OF THORIATED TUNGSTEN FILAMENTS, by Ancel St. John.

X-RAY ANALYSIS OF THE PLASTIC DEFORMATION OF ZINC, by T. A. Wilson and Samuel L. Hoyt.

QUANTITATIVE SPECTRUM ANALYSIS, by F. Twyman and D. M. Smith.

PRODUCTION OF METALLIC SINGLE CRYSTALS, by J. A. M. Van Liempt.

TWINNING IN FERRITE, by L. W. McKeehan.

Wilkinson Medal Awarded.

At the opening meeting of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen, either Mr. J. Thewlis Johnson, of Bradford Iron Works, Manchester, the donor of the John Wilkinson Memorial Medal or his representative, will present the medal to this year's winner, Mr. G. B. Poole, who is employed by Messrs. Whitehead and Poole. At the examinations held in connection with this matter, Mr. J. E. Garside (employed by Metropolitan Vickers) was second, whilst A. Buyess (H. Holidrake); H. Harrison (National Gas Engine Company); E. Hodgetts (R. and J. Dempster); and H. Nicholls (Hamilton Works) were commended.

Metallurgy Classes in London.

The Department of Chemistry and Metallurgy at the Chelsea Polytechnic, Manresa Road, Chelsea, S.W.3, reopens on September 21. These classes are controlled by Dr. C. Doree, who is assisted by Mr. W. A. Naish and Mr. L. J. Brice. There are six courses, which have been carefully chosen to meet the varying needs of both student and industry. There is apparently a certain amount of elasticity about the syllabus which should instil confidence in the minds of prospective students that the curriculum will be suited to him, rather than he to the course.

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Metallurgical Coke.

The July Bulletin of the British Cast Iron Research Association contains a short article entitled "Notes on the Manufacture and Use of Metallurgical Coke," by MR. R. BULMER (chief chemist to the Consett Iron Company, Limited), who deals briefly with the properties of metallurgical coke, and brings to notice some of the principal factors which tend to operate in the two metallurgical processes of iron smelting and refining where coke is used as fuel. He reviews the subject from two standpoints—*i.e.*, (1) Chemical composition and (2) physical characteristics.

Chemical Composition.—The chemical composition of all fuel is of vital importance, and the subject has been emphasised in most places where fuel is bought and sold. All are evidently agreed that if a commodity is sold as a fuel, it should contain as little as possible of inert or non-combustible material. From the point of view of the metallurgist, however, the purity of coke for iron-smelting and refining is of paramount importance, since, apart from its obvious inert properties, non-combustible matter represents a greater and potentially more complex series of losses, and in a recent exhaustive large-scale test on a blast-furnace plant, involving the use of about 12,000 tons of coke, it was demonstrated that an increase of 1 per cent. in the ash content of the coke charged, represented an increase in fuel consumption of 0.4 to 0.5 cwt. per ton of pig-iron produced.

Apart from the percentage present and its content of what may be termed "objectionable elements" (*e.g.*, phosphorus and sulphur compounds) the composition of the coke ash is important from the foundrymen's point of view. A very large number of cokes have been found to yield an ash of low fusion point, and in some cases the ash actually becomes plastic before the coke in which it occurs begins to burn in the combustion zone of the cupola. Since the fusion point of the coke ash is a result of its chemical constitution, care should be taken to avoid the use of coals whose ashes either individually or collectively tend to fuse easily. For foundry work, cokes having ash fusion points higher than 1,250 deg. C. should be sought. With reference to the sulphur and phosphorus content of metallurgical coke, it is noteworthy that, since both these elements (especially phosphorus) are usually found in the mineral constituents of the ash, they are often lower in low ash cokes than in those whose ash content is high. For foundry purposes a high-sulphur coke is more objectionable than one high in phosphorus, and therefore cupola processes demand coke containing less than 1 per cent. of sulphur. Moreover, under the oxidising conditions of the foundry cupola the possibility of reduction of phosphorus from its oxide is remote.

Blast-furnace coke, when used in the manufacture of hematite pig-iron, should be low in phosphorus, since practically the whole of the phosphorus enters the metallic product of the furnace. Specially-selected coals are used for blast-furnace cokes on this account. Sulphur is more easily controlled in the blast furnace, and unless the burden is high in sulphur, the coke may contain more of this element than is permissible in foundry cokes. Excessive sulphur in blast-furnace coke is disadvantageous, however, from the point of view of fuel economy, since its ultimate extraction requires three times its weight of carbon.

Physical Characteristics.—It will be seen from the above that, from the point of view of chemical composition, foundry and blast-furnace coke have certain requirements in common. In the light of physical characteristics, however, the two would appear to have only one property in common, namely, "robustness," in the sense of ability to withstand both severe shock and abrasion, as well as high compression stresses. It is well known that coke which is weak in this respect does not give good results in practice. Consideration of the relative requirements as regards coke for the two processes under notice reveals the fact that in almost all respects the one process demands opposite physical properties in the coke from the other. For instance, the foundry cupola gives best results when a strong, fairly large, slow-burning coke is used, whilst the tendency of modern blast-furnace practice is to use a well-screened, rather small-sized, strong, yet rapidly combustible fuel. The requirements of these two processes demand, therefore, two distinctly different cokes, considered from their physical standpoint.

Within recent years very great advances have been made in the technology of coal carbonisation, and, as a result, it is now possible from a given coal to produce a variety of cokes suitable for different processes and conditions. The many factors involved in the process of manufacture, however, require the use of various types of coke oven, and also of preparation of the coal before carbonisation.

The Tata Company.

Considerable excitement has been caused in Bombay by the record drop in Tata steel shares owing to the announcement that for two or three years more there is no likelihood of dividends being declared. The Bombay Native Share and Stockbrokers' Association held a meeting to protest against the manner in which the directors of the Tata Company were treating the investing public in the matter. A firm of brokers in Bombay have issued a long statement against the Tata Company. Therein they state that the proper time for the Company to convey such a gloomy foreboding was at the annual meeting. In their opinion, "if the agents had considered the shareholders' interests they would have done their best in the current year, and if at the end of the year it was found that profits were not sufficient to leave a substantial margin for return on capital, they could have applied to Government for extra protection under section 4 of the Steel Industry Protection Act, 1927." They point out that the import duty on British steel is now only fixed so far as the minimum rate is concerned, and that it may be increased whenever necessary under the above section.

The following table of output and profits is instructive :—

Year.	Production of steel. Tons.	Profits (lakhs of rupees).
1924-25	248,000	124
1925-26	320,000	146
1926-27	360,000	194

The net profits, after deducting interest and expenses for each of the years 1924-25, 1925-26 and 1926-27, is 64 lakhs, 95 lakhs and 148 lakhs respectively. From these figures it is easy to judge of the progress of the Company. It was not the bounty, but the increased production and the reduction in cost that made this possible, and with further increase in production, the profits ought to increase. The Tariff Board calculated a return of 8 per cent. on capital.

Tata's Reply.

In reply to these criticisms, the directors of the Tata Company have issued a communiqué wherein by quoting tables from the Tariff Board's report they prove that the present position of the Company is not other than that described in their recent announcement. They point out that the Tariff Board, in determining the average works cost over the whole seven-year period, have taken the arithmetic mean between the cost for August, 1926, and estimate of the cost for 1933-34. As the costs for the first of the seven years are necessarily high, and the cost of the final year are necessarily low, as a result of the new plant to be built, the profits in the earlier years will be lower and in the later years higher than the average. The directors state that this profit will not be reached until the middle of the fourth year from April of this year.

As the directors were declaring a dividend of Rs. 1 on the ordinary shares, which is the first dividend after a lapse of four years, they considered it necessary to make the announcement in order that the public might not be misled into believing that this marked the commencement of the payment of regular and increasing dividends in future years.

The communiqué contains a statement in regard to current year's production in detail which may prove of interest. The total capacity of the works for the current year is 410,000 tons of finished steel. This will increase in 1928-29 to 458,000 tons, and in 1929-30 to 490,000 tons.

The estimate of the general manager of production during the current year under the various head is as follows: Rails, 177,000 tons; structural bars and fishplates, 125,400 tons; plates, 21,000 tons; tinbars, 60,000 tons; black sheets, 9,600 tons; galvanised sheets, 12,000 tons; sleepers, 5,000 tons; total finished steel, 410,000 tons; pig-iron available for sale, 108,000 tons.

The Ac_1 Range in Special Steels.*

By Professor J. H. Andrew, D.Sc., and H. A. Dickie, B.Sc., A.R.T.C.

It has been noted by Brayshaw, Brearley, Jones and Greaves that partial hardening of certain special steels is brought about by tempering at temperatures considerably below the normal Ac_1 maximum (as obtained on a thermal curve), followed by quenching in water. Carpenter, Hadfield, and Longmuir drew attention to the fact that in thermal heating curves of nickel steels the Ac_1 change was revealed by an absorption of heat over a range of temperature commencing well below the Ac_1 maximum. Jones, from thermal and microscopical work on this subject, showed clearly that in many alloy steels Ac_1 takes place over a considerable range of temperature and is not completed at a constant temperature as in pure carbon steels. He explained this as being due to selective solution of isomorphous carbides present in alloy steels.

The aim of the present investigation was to throw some light on the extent of, and the reactions involved in, the Ac_1 range. The authors had carried out a number of experiments several years ago, with results which were considered worthy of further investigation when the opportunity arose. These experiments are described in the first section of the Paper, whereas the remainder concerns work of more recent date.

Long Soaking Experiments.

The steels shown in Table I were used:—

TABLE I.—*Analyses of Steels Employed in Experiments.*

No.	C. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Si. Per cent.	Ni. Per cent.
B ..	0.6	0.25	Low	Low	0.175	Nil
1*N* ..	0.31	0.75	0.018	0.029	0.112	3.64
6*N* ..	0.30	0.74	0.152	0.031	0.074	3.72
6 ..	0.87	0.41	0.013	0.025	0.149	3.64
7 ..	1.06	0.42	0.013	0.026	0.154	3.67

Suitable sections of these steels were subjected to the following heat-treatments:—(1) Preliminary treatment: Water-hardened at 800 deg. C. and water-tempered at 650 deg. C. Then reheated at 670 deg. C. to 690 deg. C. for 43 hrs. (2) Preliminary treatment as in (1), followed by 43 hrs.' soaking at 530 deg. C. to 550 deg. C. (3) Specimens from (2) soaked for 43 hrs. at 420 deg. C. to 430 deg. C. (4) Specimens from (3) soaked for 43 hrs. at 670 deg. C. to 690 deg. C. The specimens were quenched in water after each treatment.

TABLE II.

Treatment.	1	2	3	4	5	6	7	8	9	10	11	12
Temperature, deg. C ..	540	590	640	660	675	685	695	700	705	705 an extra	710	715
Period of heating, hours ..	24	12	12	12	12	12	12	12	12	12	12	12

The 43-hour periods were made up of several shorter periods, the specimens being quenched between each and quickly reheated, when the treatment was continued.

The Brinell hardness of each specimen was determined after each treatment, and the values are shown in Table III.

TABLE III.—*Brinell Hardness Numbers after Various Heat-Treatments.*

Steel	Treatment. 1 43 hours at 670°C. to 690°C.	2 43 hours at 550°C. to 550°C.	3 43 hours at 420°C. to 430°C after 2	4 43 hours at 670°C. to 690°C. after 2 and 3
B ..	143	196	187	129
1*N*..	241	196	179	315
6*N*..	248	217	207	342
6 ..	332	241	212	350
7 ..	277	235	220	327

* From a Paper read at the Annual Meeting of the Iron and Steel Institute.

The authors decided to carry out a more systematic and comprehensive investigation into this subject, and it was thought that the effect of heat-treatment on the specific volume might throw some further light on the reactions involved. The experiments described below were consequently carried out.

Specific Volume Determinations.

Suitable specimens of the steels, of about 25 grm. weight, were heat-treated *in vacuo* in a wire-wound electric furnace. Using furnace tubes of transparent fused silica, polished specimens could be soaked at high temperatures for long periods with only a slight tinting of the surfaces by oxidation. Three nickel steels with constant nickel and varying carbon were chosen for this work, together with a plain carbon steel for comparison as shown in Table IV.

TABLE IV.—*Analyses of Steels Employed in Specific Volume Experiments.*

Steel	C. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Si. Per cent.	Ni. Per cent.
*A*4 ..	0.71	0.16	Low	Low	0.10	Nil
2 ..	0.26	0.27	0.014	0.025	0.103	3.64
4 ..	0.44	0.33	0.015	0.038	0.125	3.65
6 ..	0.87	0.41	0.013	0.025	0.149	3.64

Specimens of each of these steels, of about 25 grm. weight, were first quenched in oil after half an hour at 850 deg. C. They were then tempered as shown in Table II.

Each twelve-hour treatment was made up of two periods of six hours each, and rapid quenching in cold water followed each treatment. There was no intervening treatment between the various tempering experiments, and on heating up for each treatment the temperature was raised as quickly as possible without overstepping the desired soaking temperature, thus preventing any appreciable redistribution of any of the constituents during the heating up.

The carbon steel (A4, Table IV) showed a softening as the temperature was raised, but little or no change in specific volume. In the case of the nickel steels when solution in γ-iron had first taken place at 685 deg. C. the quenched specimens showed an expansion and a hardening, and these increased with time and temperature. When the temperature was still further raised a contraction and softening set in, and this was followed by a second expansion and hardening at still higher temperatures just below 700 deg. C. The first expansion and hardening was associated with a duplex structure. It was clearly seen in all the specimens that the carbide dissolved progressively as the temperature was raised. As the temperature of soaking was raised the well-defined duplex structure was broken down.

The drop in specific volume and in hardness (at about 700 deg.) which follows the first rise is associated with the formation of another well-defined duplex structure which gradually separates out from the broken-up conglomerate obtained at intermediate temperatures. It was evident that austenite was being retained on quenching, and, as the amount of globularised constituent varied with the carbon content, it was concluded that this constituent consisted of austenite and the ground-mass of ferrite. As the temperature was further raised this constituent disappeared into the ground-mass and less austenite and more martensite were formed, due to the gradual dilution of the γ-iron areas.

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The unusual nature of the results obtained in this series rendered it advisable that they should be confirmed by other experiments, and a further series of similar treatments was carried out on fresh specimens of the same steels. It was thought that better quantitative results would be obtained by shorter and unbroken treatments at regular temperature intervals, and this was found to be the case.

In a second series of specific-volume experiments, fresh specimens of the steels used in the first series were oil-quenched from 850 deg. C. They were then tempered at 670 deg. C. for six hours and quenched in water. This tempering was repeated at intervals of 5 deg. C. for periods of six hours each up to 705 deg. C. Above 705 deg. C. the temperature intervals were the same, but the time of each soaking was reduced to three hours. The steels were quenched in water after each treatment. Hardness determinations were not made, as it was clear from the first series of experiments and from many other results that the hardness always followed the specific volume after treatment in the Ac_1 range except when graphitisation occurred, as in one case, namely, steel No. 6. The micro-structure was examined after each treatment, and the previous observations were fully confirmed.

A further series of three nickel steels with increasing phosphorus content, and two nickel-chromium steels, were subjected to a series of treatments similar to that used in the second series of experiments. Hardness determinations were made, and they confirmed the previous observation that the hardness increases or decreases along with the specific volume. The variation of phosphorus content did not give any marked alteration in the cycle of changes. The nickel-chromium steels gave a less pronounced increment and a smaller dip at slightly higher temperatures. As nothing substantially new was revealed by this series of experiments details are omitted.

Mechanical Tests.

It was thought that it would be of interest to determine the effect of heat-treatment within the Ac_1 range on the mechanical properties of a nickel steel. The following steel (N3) was used:—C, 0.29 per cent.; Mn, 0.65 per cent.; Si, 0.113 per cent.; P, 0.036 per cent.; S, 0.032 per cent.; Ni, 3.22 per cent. Treatment in each case was carried out on the bars before machining. Four bars of the steel, 6 in. long and 1 in. dia., were first oil-quenched from 850 deg. C. and were then subjected to a very drastic treatment at 680 to 690 deg. C. for one week. Treatment for a week at the temperature indicated brought about only a partial solution of the carbide, the micro-structure showing the usual duplex structure obtained in this region along with a fair amount of undissolved carbide, well globularised. At the end of the treatment two bars were quenched in iced brine, and the other two were very slowly cooled at a rate of 0.3 deg. C. per min. to 400 deg. C. Tensile and Izod test-pieces were machined from the treated bars. The results of the mechanical tests are shown in Table V. Four

TABLE V.—*Nickel Steel N3. Mechanical-Test Results after Various Heat-Treatments.*

Specimen.	Reduction of area. Per cent.	Elongation on 2 in. Per cent.	Maximum stress, Tons per sq. in.	Izod value. Ft.-lbs.	Brinell hardness.
1	18.5	17.5	51.2	22.7	214
2	17.9	23.4	46.4	18.3	193
3	6.45	8.8	78.4	8.3	297
4	9.0	11.0	56.4	9.8	227
5	—	20–25	55.0	60	245

Treatment: No. 1, Oil-hardened at 850 deg.C., then tempered for one week at 680 deg. C. to 690 deg. C., and water-quenched. No. 2, Same as No. 1, but slowly cooled at 0.3 deg.C. per min. No. 3, Oil-hardened at 850 deg. C., then tempered for 4 days at 695 deg. C. to 700 deg. C., and water quenched. No. 4, Same as No. 3, but slowly cooled at 0.3 deg. C. per min. No. 5, Oil-hardened at 820 deg. C., water-tempered 620 deg. C.

other bars of the same steel were subjected to a similar treatment at 695 to 700 deg. C. for four days. Two bars were quenched from the soaking temperature, and two were slowly cooled at a rate of 0.3 deg. C. per min. as before. All the carbide appeared to have been in solution at this higher soaking temperature, a prolonged boiling of the quenched micro-specimen in sodium picrate failing to show up any carbide. The slowly-cooled specimen showed a very interesting structure, in which a large part of the carbide had separated out round the grain boundaries. The effect of this structure on the physical properties of this steel has been used to provide an analogy to the behaviour of special steels in the "brittleness range."

The mechanical properties were not greatly impaired by either treatment No. 1 or No. 2, when the very drastic nature of the treatments is considered. In the case of treatments Nos. 3 and 4, in which all, or nearly all, of the carbide had been brought into solution in γ-iron at the soaking temperature, the mechanical properties were greatly affected. A large amount of martensite was produced in specimen No. 3, and, as would be expected, this gave a large increase in the tensile strength, and poor figures for the elongation, the reduction of area, and the Izod impact test.

In the bars from treatment No. 4 the carbide was found to have separated largely at the grain boundaries. It was clear from subsequent work that this was not due to segregation to the boundaries during slow cooling, but to the fact that the γ-iron solid solution had segregated to the grain boundaries at the soaking temperature, and in breaking down to pearlite at the Ar_1 point a fairly uniform layer of carbide had become deposited at the boundaries. There is no doubt that all the carbide which had been in solid solution was completely deposited by the slow-cooling treatment (the specimen was held at 430 deg. C. for 17 hours after extremely slow cooling to that temperature), and it is interesting to note how little effect the distribution of the carbide had on the tensile strength. It would have been expected that the complete separation of the carbide in specimen No. 4 would have raised the Izod value considerably when compared with specimen No. 3, but, in this case, the production of brittle carbide around the grain boundaries kept it low.

Thermal Analysis.

It was evident from the specific volume and hardness experiments that the changes within the Ac_1 range must be due to a redistribution of the constituents. Consequently the effects of similar heat-treatments followed by thermal cooling curves might be expected to give indications of the distributions involved.

It has been established that in nickel steels an increase of carbon content has no effect on the temperature of the Ar_1 change, but that an increase of nickel progressively lowers that change. Thus if nickel is redistributed in a pure nickel steel at the commencement of the Ac_1 range it would be revealed on a cooling curve by a lowering of the normal Ar_1 change, whereas if the carbide alone were concerned, no alteration in the temperature of the Ar_1 change would be observable.

The steels in Table VI were used in the thermal work.

TABLE VI.—*Analyses of Steel Employed in Thermal Work.*

Steel.	C. Per cent.	Mn. Per cent.	Si. Per cent.	P. Per cent.	S. Per cent.	Ni. Per cent.	Cr. Per cent.
N3 ..	0.29	0.65	0.113	0.036	0.032	3.22	Nil
AH ..	0.31	0.47	0.310	0.015	0.021	4.46	1.41
NC ..	0.31	0.57	0.145	0.026	0.029	3.20	0.83
NB3	0.36	0.34	0.275	0.016	0.021	1.90	1.15
AAX	0.32	0.91	0.145	0.026	0.027	Nil	0.97

The thermal specimens were treated in a high vacuum so that oxidation would be avoided. From the thermal curves of nickel and nickel-chromium steels it was shown that the temperature at which the Ac_1 range commences depends on the nickel content of the steels. The temperature at which solution in γ-iron commences was rapidly lowered by an increase of nickel. Further, it was clear that the amount of redistribution which takes place in the γ-iron first formed depends upon the amount of nickel originally present in solid solution in the ferrite.

In the chromium steel examined by the thermal method no redistribution due to the chromium (which was combined as carbide) was revealed, but the manganese present in solid solution gave an indication of effects similar to those of nickel. (The amount of lowering of Ar_1 for each 1 per cent. of manganese will be roughly 2½ times that for the same amount of nickel.) The temperature range of Ac_1 in the chromium steel was small, and it may have been entirely due to the manganese present. It is possible, however, that in steels of low chromium content there is selective solution of the carbides, as suggested by Jones. In the steel used there may be two carbides, Fe_3C and $Fe_3C.Cr_3C_2$, and these may be subject to selective solution when the Ac_1 change commences. If this does take place it can be explained by a consideration of the equilibrium in the tenary system, but for the present it is sufficient to conclude that in steels in which all the chromium is combined as carbide the temperature range of Ac_1 is small.

Where, however, a special element is present in solid solution—*e.g.*, nickel, manganese, and chromium above the $\frac{\text{4.3 per cent. chromium}}{\text{1 per cent. carbon}}$ ratio —the Ac_1 change may take place over a range of temperature, provided that there is a difference between the solubilities of the special element in α and γ-iron. The effect of nickel in this connection is specially dealt with by the authors, since in almost all of the steels used it is the element particularly concerned. They point out that a consideration of the thermal curves published by various workers, in the light of the new facts brought out by the present research, points strongly to the fact that the doubling of Ar points is due to reactions which take place in the Ar_1 range. When the start of the Ar_1 range is reached on cooling, pearlite (or troostite) starts to separate, and the remaining γ-iron solid solution becomes progressively richer in nickel, thus delaying its change until a lower temperature is reached. It is not difficult to imagine how two separate points may be produced in a cooling curve given suitable composition and conditions of cooling. In the present research three cooling curves of nickel-chromium steels were constructed. In steel *NR*3 (Table VI) (nickel, 1.90 per cent.) Ar_1 was shown by a sharp point taking place over a short temperature range. In steel *NC* (nickel, 3.20 per cent.) the composition and conditions of cooling led to a continuous evolution of heat throughout the Ar_1 range. In steel *AH* (nickel, 4.46 per cent.) the composition and conditions caused the production of two definite points, one at or near the start of the Ac_1 range, and the other at or near the end of that range. Other considerations complicate the reactions on cooling. After heating to higher initial temperatures the critical points of many special steels are lowered. This is due to causes which are not yet understood, but it may be connected with the destruction of nuclei as the temperature is raised. It is sufficient here to recognise the fact, and to point out how the position of the Ar_1 range will be altered with it. This, combined with the considerations already discussed, makes clearer the fundamental reasons for the very wide ranges of Ar_1 found in many special steels.

Contracts Open.

Constantinople, September 20.—Two drop hammers (Lufthammer), for the Chemin de Fer d'Anatolie-Bagdad. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,094.)

Rye, Sussex, September 10.—660 yds. of 6-in. cast-iron water main, with all necessary sluice valves, hydrants, etc., for the Town Council. Mr. W. J. Burnham, borough water superintendent, Landgate, Rye.

Vittlefields, I. of W., September 14.—3,300 yds. of 3-in. diam. cast-iron water mains, for the Isle of Wight Rural District Council. Mr. W. E. Blizard, engineer (Lemon and Blizard), Castle Lane, Southampton. (Fee £2 2s., returnable.)

Wellington, N.Z., October 18.—One 100-ton compression testing machine, for the Public Works Department of the New Zealand Government. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,097.)

Random Shots.

An interesting example of the widespread tendency towards standardisation which is cropping up on all hands comes from France. Two cases are cited, the first being that of the Fédération de la Méchanique, which has set up a commission to work for the extension standardisation as far as possible over the whole range of machine construction. The second is the Comité des Forges, which has likewise set up a commission, the object in this case being primarily to approach similar bodies in other European countries and especially in Germany with a view to the setting up of common standards in iron and steel.

* * *

In this connection one notes that a good deal of publicity has been sought on behalf of a conference to be held in Berlin from October 22 to November 6 on engineering materials, in conjunction with an exhibition covering the same field. From the thorough fashion in which circulars have been broadcast in English and other languages, it is evidently hoped to secure international support, although the movement appears to originate from Berlin and to be supported initially by German producers' and consumers' associations.

* * *

One ventures to hope that the German interests concerned will not overstress the international aspect of their conference, since a real international effort is being made at Amsterdam, where from September 12 to 17 a convention is being held to consider the re-establishment of the work previously done by the old International Association for Testing Materials. It is not always easy for those interested to estimate the relative importance of two such efforts, and any duplication is bound to hamper propaganda and harm the very cause which both conferences may be presumed to have equally at heart. No one objects to the German interests holding a conference and inviting foreign visitors. But the future of international materials, testing, and specifications must not be jeopardised by confusion at this juncture.

* * *

The confirmed optimist who is always convinced that trade is looking up will find support for his view in the encouraging statements recently issued concerning next year's British Industries Fair. Already, six months before the exhibition is due to open, far more space has been booked for the Birmingham section than last year's total, and the number of re-bookings and extra bookings by old exhibitors is most satisfactory.

* * *

The pessimist, on the other hand, must find considerable comfort in the reflection that in view of the direction in which our sporting tastes are tending, there can be no possible doubt that the country is going to the dogs.

* * *

A recent contributor to these columns tells us at some length his ideas on "Keeping Metal Hot." We had been under the impression that the usual method was to have a few foremen somewhere about. . . . .

* * *

The holding of a conference of Physics will mark the close of the Volta Centenary Exhibition at Como, which has been open all summer. The distinguished physicist, whose name is most familiar through its immortalisation in the "volt," is lavishly commemorated in the lakeside town, for the Italians have a strong sense of local patriotism, and one feels, further, that they have goods business heads as well, since the attractions of Como as an exhibition and conference centre can hardly be overestimated, and must have contributed very largely to the success of the whole event.

* * *

We are told that pithead baths are to be installed at a Lanarkshire colliery, and that another luxury in the district will be the provision of a light refreshment canteen. . . . . Ideas of this kind might not come amiss in the foundry—except that the refreshments would certainly need to be heavy. . . . . .

MARKSMAN.

Legal Position of Company Directors.

Powers of Borrowing Money: Certain Aspects Outlined.

BY A BARRISTER-AT-LAW.

Director a Trustee for his Company.—Although the powers of the directors of a limited company are usually laid down in the articles of association of that company, with a clause generally giving them powers of management and all such powers as are not dealt with otherwise, there is frequently difficulty in relation to the meaning and extent of those powers under certain conditions of emergency or expediency connected with business or trading problems. A company really need not have any directors, or the sole director may even be a limited company. All the members of a company may join, indeed, in carrying on its business, or it may be conducted by means of a council or committee. In general, however, a company appoints a certain few to be managers of the business and to look after its property, and they are usually designated "directors." It is not always a simple task to define their exact position, and sometimes they are mentioned as trustees, and sometimes as agents or managers of the company. To some extent directors are trustees for the company, and here it may be observed that the Statute of Limitations applies to their acts in the same manner as to trustees. But they are, of course, trustees for the company, not for individual shareholders, and never for third parties who may have made contracts with the company.

A Breach of Trust.—The courts have always exacted from directors the observance of good faith towards shareholders, and it has been long since laid down that directors who so use their powers as to obtain benefits for themselves at the expense of the shareholders, without informing them of the fact, cannot retain those benefits, and must account for them to the company. Over twenty-five years ago there was a notable case in which the directors had paid up nothing on their own shares, but had made all the other shareholders pay a specified sum on each share, partly on allotment and partly by a call. The directors there had failed to inform the other shareholders of this, and it was then held that this was a breach of trust, and that the directors must pay to the company the amount in question on each of their shares.

In another and earlier case the company had no money with which the directors' fees could be paid. The directors in that case proceeded to pay into the bank of the company the amounts outstanding on their shares and then paid the amount to themselves in satisfaction of their fees. It was thereupon held that this payment was not for the benefit of the company, and that the directors were under liability to pay the amount as still due on their shares.

Director a Paid Servant of the Company.—But directors, when described as trustees, agents or managing partners, are so described for practical purposes, and not for the purpose of exhausting their powers or liabilities. Indeed, it has been stated by a great legal authority that it does not matter much what they are called, provided it is understood what their true position is; that is to say, that "they are merely commercial men managing a trading concern for the benefit of themselves and all other shareholders in it." "The office of a director" has been said, by a great lawyer, to be, in fact, "that of a paid servant of the company," and moreover, he "never enters into a contract," as such, "for himself, but for his principal." Furthermore, in such a case he cannot sue on a contract thus made, nor can he be sued upon it unless he has exceeded his authority.

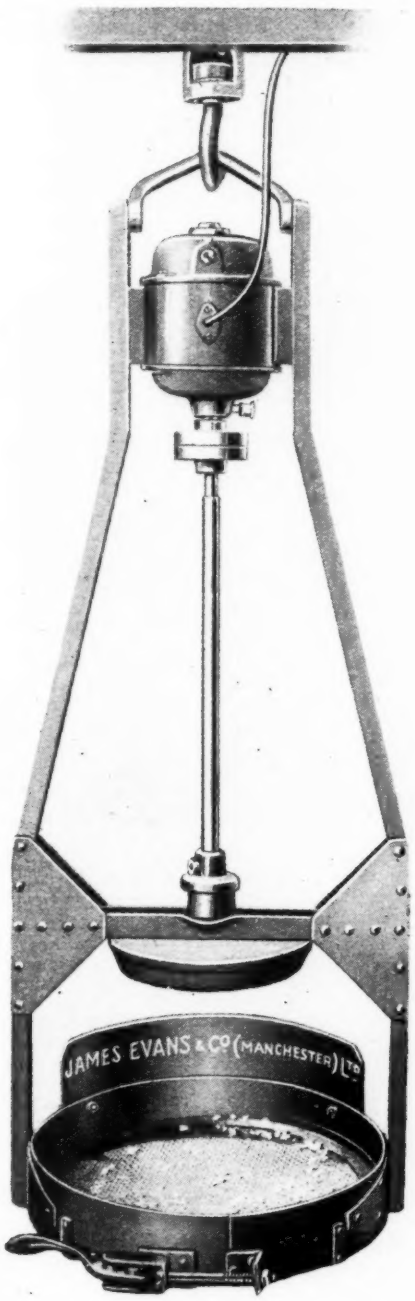
Borrowing Money.—In the necessarily limited observations of a short article it should be stated that the present object is to deal mainly with directors in relation to trading companies. Such companies have an implied power to borrow money for purposes connected with their trading. This power cannot be exercised, however, until the minimum subscription has been subscribed. If a company has power to borrow money it has, of course, the power also to charge its property as security for payment of the loan. A case tried as far back as 1891 settled this point. There a company was formed to buy and sell real estate, to accept loans on deposit, and to make advances. There was no power to borrow money in the memorandum of association of the company. But the company borrowed on the security of some of its land in order to pay back a deposit. The Court held that, being a trading company, it had full power to borrow and to charge its property. The borrowing powers of a trading company are, in general, exercised by the directors, but this may depend on the articles of association. It is only necessary to add that as regards other companies there is no such power, unless it is contained in the memorandum of association, but that this may be met by applying to the Court to extend the memorandum.

When a company borrows money it may be secured by several methods. There may be a legal mortgage of specific parts of its property. If freehold or leasehold property be mortgaged, registration is necessary on the company's register; and also on the register kept by the Registrar, if it is a mortgage of land, or for the purpose of securing an issue of debentures, or falling under certain other conditions. Non-registration in the company's register, under the Companies Act would not make a mortgage void, but, under that Statute, in the other case it would have that effect. There may be also an equitable mortgage by deposit of title deeds, as a means of borrowing money; a mortgage of any other kind of property, such, for example, as stock in trade, machinery or plant; and there may be bonds given as well as promissory notes and bills of exchange. Floating charges may be also made, evidenced by debentures, and debenture stock may be likewise created. Most business people will readily understand that the difference between a debt secured by debentures and debenture stock largely resembles the difference between shares and stock.

Director as Agent for his Company.—A director, it will be seen, may be placed either in the position of a trustee or an agent for his company. The first of these positions has been already referred to. When directors, however, as agents for their company, make a contract for that company, they do not make themselves legally liable unless they contract in their own names. If they do this then the other party has the option of suing either the company or the directors themselves. But supposing that the directors, in making a contract, make one which is *ultra vires?* In such circumstances the act of the directors cannot bind the company, and they do not render themselves liable, except that a right of action may have arisen against such directors on an implied warrant of authority. If the contract in question is not beyond the powers possessed by the company, but only beyond the powers of the directors, then, if that contract is made with a member, it is voidable, but if made with a non-member, provided the latter had no notice of the want of powers, it binds the company. It should be mentioned that such an act of the directors may be also made valid by the acquiescence of all of the shareholders.

Implied Warrant of Authority.—Supposing, further, that a company borrows beyond its powers, the borrowing being *ultra vires* and void and the securities being void? The lender, in such circumstances, it is true, cannot sue the company for the return of the loan, but he can obtain an injunction to prevent the company from parting with it, or, as already indicated, he may proceed against the directors upon the implied warrant of authority. If the money has been used to pay off debts which could have been enforced against the company, the lender may also sue the company, being subrogated to the rights of the creditors who were paid off. It is important to remember, however, that such subrogation does not give the lender the same priority that the original creditors had over the other creditors of the company. It should be explained, perhaps, that the principle applied is that a company which borrows to pay off existing debts does not thereby increase its liabilities. It may be added that a company cannot borrow on the security of its reserve capital. The latter cannot be turned into ordinary capital without leave of the Court, and it cannot be dealt with or charged by the directors of a company.

EVANS'S ELECTRIC
GYRATORY FOUNDRY RIDDLE



THE saving accomplished by the use of our Electric Gyratory Riddle pays for the cost of the machine in a few weeks' time.

It will sift more sand with one operator than six men sifting by hand. In addition to this it mixes the sand better, and produces a better grade than hand labour.

The machine is portable and may be moved to any place in a few moments (where a hook for suspension is available and electric current in service) and set in motion instantly.

Motor and working parts are all above the sieve, thus preventing the sand from interfering with the operation of the machine.

Power required, ¼ B.H.P.

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BRITANNIA WORKS,

BLACKFRIARS, **MANCHESTER.**

Foundry Purchasing—XII.

BY ERIC N. SIMONS.

The storekeeper is only interested in the three principal divisions of purchasing, *i.e.*, raw materials, works materials and maintenance supplies, and materials for re-sale. The fourth class of purchases—stationery and office supplies—as a rule, is kept separate from the general stores, and is treated rather differently. He keeps no records of stocks for these, nor does he himself stock them. Instead, he notifies the buying department of their arrival, and delivers the goods to them. Any packages or parcels that do not arrive by rail or canal are generally delivered direct to the buying department. The stationery and office supplies are usually kept in a special stock room in or near the buying department itself, and a stationery and office supplies clerk acts as storekeeper, issuing them as required to the various office departments, and behaving in exactly the same way as the storekeeper of the general stores. In a sense, these commodities give occasion for a sub-stores. The reason is obvious. Stationery supplies, etc., are required at every end and turn by the various offices; it would be absurd to have to keep a staff of errand boys running to and from the large general stores for half a dozen pen-nibs, or a packet of duplicating paper, or a typewriter ribbon, every five minutes. The stationery, being kept in or near the buying department, is under the immediate supervision and control of the buyer: is within easy reach of those who need it: and can be stored more effectively and appropriately than the works stores could store it.

Material Equipment.

No business man needs to be told that he ought to possess proper desks, typewriters, and so forth. Ludicrous commonplaces of this kind belong to the cheaper "business" magazines so popular among junior clerks in the United States. But what he does need to be told is the importance of ensuring efficient communication between the buying department, the suppliers, the works departments, and the offices. This means not only that the national telephone must be connected with the department itself from the main switchboard, but that, if necessary, there must be more than one extension, so that in the event of an assistant desiring to call up a supplier for information, the buyer himself is not kept waiting to telephone on important business until the first conversation is finished: and *vice-versa*. Secondly, it means—if the foundry is important—that there must be private telephonic communication lines between the buying department and the various works departments and offices. This may be provided by one of the elaborate automatic systems rapidly finding favour among large concerns. Without it, the buyer will find his efficiency almost halved.

Another important point is the provision of adequate waiting-room accommodation for salesmen. It seems to be considered by many managements that a salesman is a nuisance, whose visits should be discouraged rather than appreciated. Therefore, they provide the minimum of waiting-room accommodation for the buyer's visitors. In one instance known to the writer, it is no uncommon sight to see three or four salesmen lined up along a corridor, waiting until the one small room provided is vacant. Meanwhile, in this tiny room, barely furnished, and separated from another office by a mere partition of wood and glass, the buyer is interviewing a supplier's representative. Every word they utter can be overheard in the next office. There is no table on which samples can be spread out and examined. And the management expect that negotiations can be properly carried on in these irritating circumstances. Furthermore, consider the difficult position in which the buyer is placed in regard to the men waiting outside. They know he is there. He cannot evade them. They are ready to pounce upon him, and he cannot well thrust them away on his emergence. He has either to be rude to them, or grant to them the same privilege as he has already granted to their predecessor. Among them may be men he does not wish to see; men whom he would turn over to his assistant. The disadvantages of insufficient waiting-room accommodation are, or should be, self-evident. These disadvantages are increased when, as in the specific instance mentioned, the one waiting-room is not devoted solely to the buyer's use, but is used generally for every visitor. When a manager is interviewing someone, the buyer has then to stand on the corridor talking to a salesman—within sight and hearing of anyone who happens to pass—or to take the salesman into his own office, which he may not wish to do for various reasons (*e.g.*, he may have important charts hanging on his walls, that would reveal valuable facts to any salesman).

Waiting-Rooms.

One other result of insufficient waiting-room accommodation is that bold and brazen salesmen develop the habit of walking into the buyer's own office without permission, or into the buying department. When they walk into the buyer's room, they often do so on the pretext that they were directed by "someone" they met "in the corridor" or "on the stairs." It is difficult to refute this argument, because there is always the possibility that some member of the firm, ignorant of the buyer's rules in regard to interviewing salesmen, may have given the direction suggested. But it is always safe to be sceptical, and the experienced buyer can usually tell at a glance whether the "mistake" is genuine or not. A safe plan to follow in such cases is to refuse to discuss business with the intruder then and there, whether his incursion is due to error or deliberate scheming, and to instruct an assistant or office-boy to escort him to the waiting-room until the buyer is ready to see him. Salesmen are speedily cured of their peripatetic tendencies if treated firmly but gently in this way.

When the salesman wanders into the buying office itself, it is more difficult to deal with him, since the staff may not know for certain whether he is someone whom the buyer is in the habit of seeing, and his very effrontery in walking in suggests that he is on more or less friendly and intimate terms with the chief. The best plan is to leave strict instructions that any representative who enters the buying office without permission or invitation should be sent back to the waiting-room, or wherever else is appointed for the reception of salesmen.

Some remarks on the general appointments of a salesman's reception-room may here be given. There should be, as already intimated, a table on which samples can be laid, blue-prints and plans laid out, documents signed or notes written. Lighting should be good, so that inspection of samples can be thorough and minute. There should be adequate seating accommodation, and racks for hats, sticks, etc. If magazines or literature are provided to while away long waiting periods, it is a good plan to drop in among them a few of the firm's publicity brochures or house organs. Salesmen sometimes look at these with interest, and in conversation with their chiefs may casually mention facts gleaned from them about their customers that lead to reciprocal business. There should be private telephonic communication with the works, so that, if necessary, the buyer can obtain information needed without leaving the room. This has often a psychological effect not to be despised, since the absence of a buyer during a critical moment in negotiation often gives the salesman a chance to regain confidence and revise his decisions. There should be available pens, paper, ink, and blotter, for the use of either party. A bell of some sort, either electric or hand, should be accessible to the salesman, so that on going into the waiting-room—as, if he has called upon the firm before, he will know it is policy to do—he can indicate his presence to the buying department, with which this bell should communicate. It is advisable to fix a notice to the bell to indicate its use to the salesman not familiar with this method of procedure. An important point often overlooked is that the windows of the waiting-room should not command any part of the works that needs to be kept private. In one establishment, the waiting-room commanded a view of a department where steel castings were treated in a certain way peculiar to the firm, the secret of which needed to be kept. Eventually the secret leaked out in this way.

ALUMINIUM ALLOYS
B.E.S.A. Standards

(Part of) Aluminium Data Sheet A 121

Specification. No.	Specified Chemical Composition.[1]	Description.	Minimum Tensile Properties.[2]	
			Ultimate tens. str. Tons sq. in.*	Per cent. elongation in 2 in.
3L11	*Copper* 6% to 8% ... *Tin* may be used up to 1%	Casting alloy	9	3
2L8	*Copper* 11% to 13% ...	Casting alloy	9	Nil
2L5	*Zinc* 12.5% to 14.5% *Copper* 2.5% to 3.0% ...	Casting alloy	11	3
L24	*Copper* 3.5% to 4.5% *Nickel* 1.8% to 2.3% *Magnesium* 1.2% to 1.7%	"Y" alloy castings	11	Nil

[1] In each of the above alloys the remainder consists of aluminium and normal impurities.
[2] Tensile tests for casting-alloys are made on specimens machined to .564 in. diameter from samples cast 1 in. diameter in a heated iron chill. Tensile tests for sheet are made on stamped specimens with width ½ in. to 1½ in., and parallel length 2½ in.

F.T.J. 18/6/27.

Weight saving and aluminium are synonymous. So every engineer knows. When it is to be decided who shall mix the alloys, there's a choice between ready-mixed

Aluminium Alloys

B.E.S.A. or B.A. Co., and the virgin B.A. Co. notched bars.

THE BRITISH ALUMINIUM CO., LTD.,
ALUMINIUM PRODUCERS,
ADELAIDE HOUSE - LONDON, E.C.4.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.
DEEPCAR, Nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

TEAM BY-PRODUCT COKE CO., LTD.
DUNSTON-on-TYNE
"TEAM" PATENT COKE
SPECIAL FOUNDRY QUALITY

FOR PRICE AND PARTICULARS APPLY TO:—
ALEXANDER LEITH & CO.,
25, COLLINGWOOD STREET,
NEWCASTLE-ON-TYNE.

TYPICAL ANALYSIS (*if necessary guaranteed*)
ASH not exceeding 8%
SULPHUR " " 0.8%
VOLATILE " " 1 %
MOISTURE under 1.50%

Trade Talk.

CONSIDERABLE DAMAGE WAS caused by fire at the premises of P. & C. Garnett, Limited, machine makers, Cleckheaton, on August 28.

A CONTRACT FOR a steamer of 6,500 tons deadweight capacity has been placed with the Ayrshire Dockyard Company, Limited, Irvine, by George Nisbet & Company, Glasgow.

THE GROVESEND STEELWORKS at Gorseinon was put into full commission during the week-end, an additional furnace, to make a total of five, being started. A fifth furnace at the Bryngwyn Steelworks, Gorseinon, was also re-started.

CROFTS (ENGINEERS), LIMITED, Thornbury, Bradbury, Yorks., have just opened up their new steel foundry, and in future they will be able to supply steel castings (electric process) up to 5 tons weight, with a capacity of 100 tons weekly.

FOR THE FIRST TIME since the war the Council of Swedish railways has placed an order for rails in the country itself. The Stora Kopparbergs Bergslags A.B. has received an order for 1,000 tons, although their tender was 18½ per cent. higher than the lowest foreign offer.

RUSTON & HORNSBY, LIMITED, Lincoln, have secured from the Crown Agents for the Colonies a contract for pumping plant in connection with Bahama's water supply. The plant comprises two pumps to deliver 500 gallons per minute to a height of 83 ft., two electric motors, and two large Rushton oil engines as a stand-by in case of failure of current.

THE GRINDING AND PULVERISING OFFICES of International Combustion, Limited, 11, Southampton Row, report that orders have recently been received from England for two Hummer electric screens; from France for seven Hardinge ball mills, classifiers, Raymond mills, pulverisers, etc.; from Spain for two Hardinge ball mills; and from the Dutch East Indies for three Hardinge ball mills.

THE MIRRLEES WATSON COMPANY, LIMITED, Scotland Street, Glasgow, have orders for one pump of 75,000 gallons per hour capacity against a head of 207 ft. for the Mid-Kent Waterworks, and two for the Harpenden Waterworks, Herts., each of 40,000 gallons per hour capacity against a head of 258 ft. The three pumps are to be driven by "Mirrlees" Diesel engines. The company are also supplying one borehole pump for the Chiltern Hills Water Company, duty 30,000 gallons per hour against a head of 242 ft., this being driven by A.C. vertical motor. In addition to the borehole pump for Mid-Kent, the contract includes four turbine pumps giving a total capacity of 124,000 gallons per hour. These pumps will also be driven by "Mirrlees" Diesel engines.

THE MOSSEND (LANARKSHIRE) rolling mills of Messrs. William Beardmore & Company, Limited, have been employed for some time past on the fulfilment of several important orders from abroad for road rails. The principal contract is for over 7,150 tons for the Government of Esthonia. It includes 6,320 tons of rails, the balance being fishplates and other accessories. Shipment is being carried out entirely by the Esthonian Government in their own steamer, the "Kajak," from Grangemouth. The first consignment was of 2,000 tons, the second—delivered towards the end of June—of 3,000 tons, and the final consignment was loaded at the end of August. It may be recalled that the Mossend steel works of William Beardmore & Company, Limited, underwent a complete reorganisation after the war period, and are now amongst the most modern engaged in this important class of work.

WALKERS, PARKER & COMPANY, LIMITED, lead smelters and manufacturers, of 63, Belvedere Road, Lambeth, S.E., write that certain references to the closing of their lead works at Bagillt (Flintshire) owing to slackness of trade and foreign competition might create a wrong impression. Originally built in 1794, these works passed through several ownerships before the leases were purchased from the Halkyn Adventurers by Walkers, Parker & Company in 1834. At that time only a single row of smelting furnaces and a slag hearth existed, but additional land having been acquired considerable extensions were made, and in the prosperous days of the Welsh mining industry smelting operations were profitable. The steady closing down of the local mines owing to their flooded condition caused the supply of ores to become a negligible quantity. The directors were bound to recognise that the Bagillt works had served their purpose, and thereupon, as a matter of policy, decided to utilise more fully the large modern smelting plant at the company's Newcastle works, competent to deal with all available British ores, and to concentrate the remaining processes at the Chester works, where they have been installed under improved conditions.

Personal.

MR. JOSEPH ARROWSMITH, who is shortly relinquishing his position as manager of the smelting department of the Earl of Dudley's Round Oak Works, has been presented with a gold watch by the members of the Round Oak Branch of the Iron and Steel Trades Confederation.

WE UNDERSTAND that the announcement of Sir Vincent Caillard's resignation from the directorate of Vickers, Limited, is now officially confirmed. Sir Vincent Caillard has been a director of Vickers since 1898, when the title of the company was

SIR VINCENT CAILLARD.

Vickers, Sons & Maxim. Under the Vickers reconstruction scheme, which came into operation in January last year, Sir Vincent Caillard was appointed chairman of the Finance Management Board, instituted to control all matters in connection with the finance of the company and its subsidiaries. Sir Vincent is a past-president of the Federation of British Industries, and a director of John Wilkes, Sons & Mapplebeck, Limited.

Wills.

RITCHIE, A., of West Hill, Highgate, N., iron merchant	£1,868
MOTT, J., 8, Valentine Road, King's Heath, Birmingham, retired brass founder	£19,088
LEGG, G. A. T., Penn Road, Wolverhampton, managing director of Edwin Lewis & Sons, tube manufacturers, Ettingshall, Wolverhampton	£6,089

Company Notes and News.

A. E. Godrich & Son, Limited, Wharf Street, Aston, Birmingham.—Capital £20,000 in £1 shares (10,000 preference and 10,000 ordinary). Engineers.

Heybrook Welding and Engineering Company, Limited.—Capital £2,500 in £1 shares. Directors: L. Cavaghan, 142, Heywood Road, Castleton, Rochdale; and J. R. Mellor, 129, Bolton Road, Marland, Rochdale.

Elliott's Metal Company, Limited.—Profit, £57,162; brought in, £54,266; total, £111,428; dividend on preference shares, subject to tax (of which an interim dividend amounting to £5,630 has been already paid), £11,261; dividend, 2s. per share on ordinary shares, subject to tax, £44,298; carry forward, £55,869.

Tata Iron and Steel Company, Limited.—At the annual meeting, at Bombay, the chairman stated that the directors had agreed to the Tariff Board's estimates for the next seven years on the average, but he thought a larger measure of protection was necessary in the earlier years. He warned the shareholders that results for the earlier years could not approximate to those obtained in 1926-27 unless there was some very great rise in prices of foreign steel. The company, he said, was steadily reducing costs and increasing production, while the price of coal had fallen. The estimated production for 1927-28 was 410,000 tons of steel. The company had asked for greater protection, but it was no good making further representations.

REGARDING THE SALE of the rolling mills at Newburn lately belonging to John Spencer & Sons, Limited, mentioned in our last issue, the purchase of the same was arranged under the Court. The firm of Wheatley Kirk, Price & Company, of London, Manchester and Newcastle-upon-Tyne, were the valuers appointed by the Court in this matter.

"SERVICE GRC FIRST"

To the Ironfounders of Scotland!

ROMANCE—AND SAND

The "Blue Bells of Scotland"—famous the world over—never grow in sweeter profusion than on Loudoun's "Bonnie Banks and Braes"—sung wherever Scots do foregather.

In the dells around Loudoun Castle in Ayrshire (the ancestral home of the Earls of Loudoun) they shimmer every springtime, a blue mist in the woods, to the joy of the early bee and the local youth.

But the Loudoun lands enfold treasures which appeal to the practical mind of the Ironfounder of Scotland as powerfully as do the flowers to his sentimental side and his sense of beauty (and what Scottish Foundryman is devoid of either ?).

For the justly celebrated "Loudoun Sand Rock" is found here, and here alone, and the Countess of Loudoun has concurred in an arrangement whereby the General Refractories Company, Ltd., of Sheffield, are quarrying the rock and preparing it for the Foundry in a plant which is the last word in "fool proof" efficiency, and erected within sight of that grey pile which could tell the bloody story of Scottish history, if stones had eyes and tongues.

In all Scotland there is no such plant, so adequate, so certain in its action, so regular in its results, and, withal, so economical and inexpensive to operate.

The arrangement of the plant is the result of fourteen years' experience of Foundry Sand preparation by the General Refractories Co., Ltd., which probably supplies more Foundry Sand than any other producer in Great Britain, and the result is a sand of which its makers are proud.

They now offer it with confidence that it will enhance their reputation and be in accord with their freely stated principles of "Service First"—which, translated into practice or, "getting down to brass tacks," means that they desire only to deliver goods which will cause their recipients neither worry nor bother, but, will, on the other hand, enable them to do their work more easily, more profitably, and more happily.

The Loudoun Rock Sand will do this. It is a soft, well-bonded, yellow sand, absolutely free from lumps, stones or pieces of clay, and of such reliable regularity that it may be used every day in the week to form part of a mixture without the slightest need to alter the proportion of it which the mixture contains.

It is not so close and dense that venting between its pores is impossible, but it dries in the mould with a surface smooth enough to ensure a clean blue skin on the casting, strong enough not to be broken by a rush of metal, and refractory enough not to burn on or cause unsightly scabs.

We have here a rare combination of valuable qualities which explain the steady growth in its sales, and the constant unsolicited repeat orders which are continually being received.

It will be a pleasure to the Company to receive applications for free sample bags, which will be sent carriage paid to any part of the country.

From resources also entirely on the lands of Loudoun, there is also being produced the "Loudoun Loam Sand," a dense, strongly bonded sand in great favour for many jobs.

This is just as reliable as the Rock Sand and is offered with the same confidence—samples of this also, free on application.

Many British Ironfounders are users of Scottish Rock Sands and are invited to make a free test of these two sands, produced under ideal conditions, of faultless quality, and at a price which compares favourably with any other on the market.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—A further unexpected development of the recent revision in Cleveland iron prices was marked at last week's market, when it was announced that all conditions as to tonnage should be waived and that, irrespective of quantity, all orders from Scotland or abroad should be accepted on a flat rate of 2s. 6d. per ton below the home price. This concession has had an encouraging effect upon the trade in Tees-side, and during the past week there has been a marked improvement in business at home and abroad. Shipments have improved, and inquiries are circulating which justify the more optimistic tone of the market. The revised prices of Cleveland iron are now as follow:—Home market: No. 1 Cleveland foundry iron, 70s.; No. 3 Cleveland G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton. For export or to Scotland, No. 1 Cleveland foundry, 67s. 6d. per ton; No. 3 Cleveland G.M.B., 65s.; No. 4 foundry, 64s.; No. 4 forge, 63s. 6d. per ton.

The outlook in the Tees-side hematite market continues disappointing, with only a limited business passing. For small quantities producers still quote 75s. per ton for mixed numbers, and 75s. 6d. for No. 1 quality, but for bigger orders prices are being shaded to the extent of 6d. or 1s. per ton, and some export orders have been taken at still lower figures. On the North-West Coast, Bessemer mixed numbers are quoted at 75s. per ton, at works, while low-phosphorus iron is 5s. per ton above that figure.

LANCASHIRE.—Markets for foundry pig in this locality, though hardly more active than recently reported, are certainly steadier in tendency. It may, however, be noted that there has been little movement in prices since last week, Derbyshire brands being obtainable for delivery in this district at round 74s. per ton, Staffordshire at 74s. 9d., Cleveland at 80s. 8d., and Scottish at 92s. 6d.

THE MIDLANDS.—Notwithstanding the low prices ruling in local markets, so far the demand has not shown any appreciable improvement. Consumers are still restricting their purchases to small lots. Quotations remain practically stationary, Northants ruling from 60s. to 61s.; Derbyshire No. 3, 65s. to 66s.; and South Staffordshire also at the latter levels, all f.o.t. furnaces, with Scottish round about 91s. 6d. delivered locally.

SCOTLAND. — Consumptive demand for Scotch foundry pig continues much below the usual volume at this season, and prices are again a shade easier at 74s. 6d. for No. 3 foundry, f.o.t. furnaces.

Finished Iron.

Conditions in the markets for most descriptions of finished material continue unsatisfactory, manufacturers generally finding it difficult to maintain full time at works. At Birmingham it is reported that it is possible to buy a good crown iron at £9 15s. per ton from works and outside, whilst nut and bolt iron is offered round about £9 per ton. Marked bars are unaltered at £13 10s. at makers' works.

Steel.

The depression recently prevailing in the steel industry appears to be gradually subsiding, and at Sheffield the demand for both acid and basic billets is slightly better. Siemens acid billets make £10 per ton, soft basic billets £7, and hard ditto from £8 2s. 6d. to £8 12s. 6d. per ton, all delivered. Buying of Continental billets is less pronounced, but a fair quantity continues to come into this district.

Scrap.

Consumers of cast-iron scrap still evidence little inclination to do business, but, on the other hand, prices are so depressed that merchants feel that values cannot well fall lower, and are showing reluctance to force sales. In Scotland heavy machinery cast-iron scrap is still a drug on the market, and is difficult to dispose of even at 70s. per ton. Heavy ordinary cast-iron scrap is being offered at 65s. per ton, with few buyers. Old cast-iron railway chairs, on the other hand, are around 70s. per ton, but the supplies available are small. Light cast-iron scrap is unchanged at 57s. 6d. and 58s. 6d. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—The market for standard copper of late cannot be said to have offered much variety in the general tendency of quotations, which continue confined within very narrow limits, though fairly steady on the whole. The margin between standard and fine copper having widened again a good deal lately, it is not surprising that sellers of the former in the open market have become a little more reserved.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £54 12s. 6d. to £54 13s. 9d.; Friday, £54 12s. 6d. to £54 13s. 9d.; Monday, £54 15s. to £54 16s. 3d.; Tuesday, £54 13s. 9d. to £54 15s.; Wednesday, £54 13s. 9d. to £54 15s.

Three Months : Thursday, £55 2s 6d. to £55 3s. 9d.; Friday, £55 2s. 6d. to £55 3s. 9d.; Monday, £55 5s to £55 6s. 3d.; Tuesday, £55 5s. to £55 6s. 3d.; Wednesday, £55 3s. 9d. to £55 5s.

Tin.—Although there has been a slight increase in demand for standard tin on American account recently, home requirements are still on a restricted scale, and the fact has to be noted that the premium on prompt delivery has now dwindled to less than £3 10s. per ton, which compares with about £6 a week previously. Of course, the spot position has been made distinctly easier on account of the considerable quantities which have been put into home warehouses.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £288 5s. to £288 10s.; Friday, £289 to £289 5s.; Monday, £289 10s. to £289 15s.; Tuesday, £290 to £290 2s. 6d.; Wednesday, £290 10s. to £290 15s.

Three Months : Thursday, £284 to £284 5s.; Friday, £284 10s. to £284 15s.; Monday, £284 5s. to £284 10s.; Tuesday, £284 10s. to £284 12s. 6d.; Wednesday, £284 10s. to £284 15s.

Spelter.—The decline of values of ordinary spelter recently may be chiefly attributed to sympathy with a corresponding movement in lead, while home demand also is unsatisfactory at the moment. The difference in value between the two metals is abnormally wide, for while the American output of zinc has been curtailed a good deal, no contraction has occurred in the world's lead production.

The following are the week's prices :—

Ordinary : Thursday, £27 5s.; Friday, £27 6s. 3d.; Monday, £27 12s. 6d.; Tuesday, £27 10s.; Wednesday, £27 11s. 3d.

Lead.—The recent cut in American prices has been promptly followed by a similar movement in the market for soft foreign pig on this side, and quotations fell to a new low record for the year for prompt delivery. The latter is at a discount of 8s. 9d. as compared with forward metal, due to the existence of a large surplus and the continued lack of animation in the trade demand.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £22 8s. 9d.; Friday, £22 7s. 6d.; Monday, £22 2s. 6d.; Tuesday, £22 2s. 6d.; Wednesday, £22.

Institute of British Foundrymen.

LONDON BRANCH.

The inaugural meeting of the London Branch will be held at the Engineers' Club, Coventry Street, W.1, on Thursday, September 15, at 8 p.m.

Mr. Lake will give his presidential address, entitled "The Future of the Industry."

Obituary.

MR HERBERT INGOLD, of Woolley House, Wincobank, Sheffield, chairman and managing director of the Sheffield Wire Rope Company, Limited, died on August 27, aged 62. Mr. Ingold was born in Essex, but went to Sheffield in 1887, when he joined the firm of William Cooke & Company, Limited. He left them in 1909 to found the Sheffield Wire Rope Company.

MR. WALTER HENRY MAUDSLAY, for 33 years a member of the marine engineering firm of Maudslay, Sons & Field, of Lambeth, London, S.E., which was founded by his grandfather, Henry Maudslay, the inventor of the lathe slide-rest, died at Falmouth on Thursday, August 25, aged 83. Mr. Maudslay was also managing director and chairman of the Birmingham Aluminium Casting (1903) Company, and for 35 years had been a director of the Employers' Liability Assurance Corporation, of which he was an original member of the board. For several years he was South of England chairman of the Iron Trades Employers' Association, and subsequently vice-president of the Federated Employers of Great Britain.

SIX REASONS WHY

YOU SHOULD EQUIP YOUR FOUNDRY WITH

Sterling

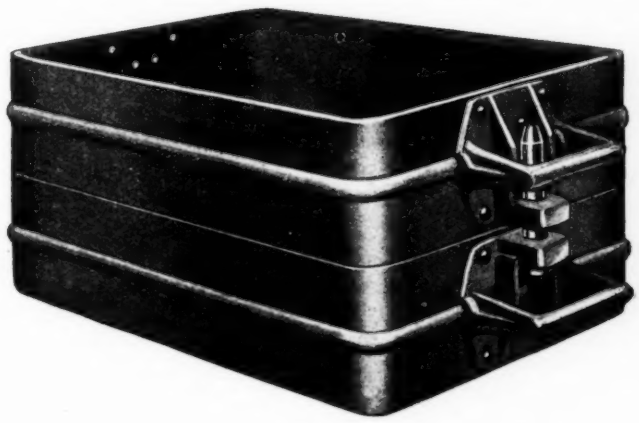
BOXES

You will—

Halve your moulding costs ;
Increase production per man per hour ;
Reduce your Box maintenance costs ;
Turn out more accurate castings ;
Prevent wasters and rejects ;
Reduce your fettling costs.

Sterling Boxes save their cost in a few months and are a sound investment for any Foundry.

LET YOUR NEXT LOT OF BOXES BE "STERLINGS."



STERLING FOUNDRY SPECIALTIES LTD.
BEDFORD

London Office: 13, VICTORIA STREET, S.W.1.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	54	13	9
Three months	55	3	9
Electrolytic	62	0	0
Tough	59	0	0
Best selected	60	0	0
Sheets	86	0	0
India	72	0	0
Wire bars	62	5	0
Do. September	62	5	0
Do. October	62	5	0
Ingot bars	62	5	0
H.C. wire rods	66	15	0
Off. av. cash, July	54	11	8 5/16
Do. 3 mths. July	54	19	9 1/16
Do.,Sttlmnt. July	54	11	6 3/4
Do., Electro, July	60	6	6 3/4
Do., B.S., July	58	15	3 1/2
Aver. spot price copper, July	54	11	8 1/2
Do., wire bars, July	60	11	3 3/4
Solid drawn tubes			12 1/2d.
Brazed tubes			12 1/2d.
Wire			9 1/2d.

BRASS.

Solid drawn tubes	11 1/2d.
Brazed tubes	13 1/2d.
Rods, drawn	10 1/2d.
Rods, extd. or rlld.	7 1/2d.
Sheets to 10 w.g.	9 1/2d.
Wire	9 1/2d.
Rolled metal	9 1/2d.
Yellow metal rods	7 1/2d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8 1/2d.

TIN.

	£	s.	d.
Standard cash	290	10	0
Three months	284	10	0
English	288	0	0
Bars	290	0	0
Straits	295	10	0
Australian	295	0	0
Eastern	288	17	6
Banca	300	0	0
Off.avr.cash, July	288	16	3
Do., 3 mths., July	281	19	3 3/4
Do., Sttlmt. July	288	15	11 1/2
Aver. spot, July	288	16	3

SPELTER.

	£	s.	d.
Ordinary	27	11	3
Remelted	25	15	0
Hard	21	10	0
Electro 99.9	30	17	6
English	28	0	0
India	23	15	0
Zinc dust	36	0	0
Zinc ashes	9	5	0
Off. aver., July	28	3	0 3/16
Aver., spot, July	28	5	7

LEAD.

	£	s.	d.
Soft foreign ppt.	22	0	0
English	23	10	0
Off. average, July	23	14	2 1/2
Average spot, July	23	9	9 1/4

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	36	0	0
Do. V.M. ex whf.	34	10	0
Rods	42	0	0
Boiler plates	34	0	0
Battery plates	33	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	65	0	0
Chinese	46	10	0
Crude	37	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	21	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 15 0
45/50%	£12 12 6
75%	£19 17 6
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11 1/2d.
Ferro-phosphorus, 20/25%,	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/8 lb.
Ferro-chrome	
2/4% car.	£33 15 0
4/6% car.	£23 15 0
6/8% car.	£22 17 6
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£42 0 0
Max.0.70% car.	£54 0 0
70%, carbonless	1/4 1/4 lb.
Nickel—99%, cubes or pellets	£170
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105
Metallic chromium—	
96/98%	3/- lb.
Ferro-manganese (net)—	
76/80%, loose	£12 0 0
76/80%, packed	£13 0 0
76/80%, export	£11 15 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. d. 2 6
Finished bars, 18% tungsten	3 0
Per lb. net, d/d buyers' works.	
Extras—	
Rounds and squares 3 in. and over	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/8 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do. under ½in. × ¼in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra.
Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.
Per lb. net, d/d steel makers' works.	

SCRAP.

	£	s.	d.
South Wales—			
Hvy. steel	2 17 6 to 3	0	0
Bundled steel & shrngs	2	10	0
Mixed iron & steel	2	12	6
Heavy cast iron	2 19 0 to 3	0	0
Good machinery for foundries	3 0 0 to 3	2	6
Cleveland—			
Heavy steel	2	15	0
Steel turnings	2	4	6
Cast iron borings	2	2	6
Heavy forge	3	12	6
Bushelled scrap	3	3	0
Cast-iron scrap	3 1 0 to 3	5	0
Lancashire—			
Cast-iron scrap	3	5	0
Hvy. wrought	3	2	6
Steel turnings	2	2	6
London — Merchants' buying prices delivered yard.			
Copper (clean)	48	0	0
Brass (clean)	38	0	0
Lead (less usual draft)	20	10	0
Tea lead	18	10	0
Zinc	18	0	0
New aluminium cuttings	80	0	0
Braziery copper	45	0	0
Gunmetal	48	0	0
Holiow pewter	170	0	0
Shaped black pewter	130	0	0

PIG-IRON

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	75/6
Hematite M/Nos.	75/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
,, d/d Birm.	92/- to 95/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	—
,, No. 3 fdry.	65/- to 66/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	55/-
,, fdry. No. 3	60/- to 61/-
Derbyshire forge	—
,, fdry. No. 3	65/- to 66/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	74/6
Hem. M/Nos.	76/6
Sheffield (d/d district)—	
Derby forge	68/6
,, fdry. No. 3	70/6
Lincs. forge	—
,, fdry. No. 3	70/6
E.C. hematite	85/-
W.C. hematite	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	74/-
Northants foundry No. 3	—
Dalzell, No. 3	105/- to 107/6
Summerlee, No. 3	92/6 to 100/-
Glengarnock, No. 3	92/6 to 100/-
Gartsherrie, No. 3	92/6 to 100/-
Monkland, No. 3	92/6 to 100/-
Coltness, No. 3	92/6 to 100/-
Shotts, No. 3	92/6 to 100/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.) nom.	9 15 0 to 11			0	0	
Angles				—		
Tees to 3 united ins.				—		
Nut and bolt iron				—		
Hoops				14	10	0
Marked bars (Staffs.) f.o.t.				13	10	0
Gas strip				12	10	0
Bolts and nuts ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates				8	2	6
Boiler plts.				11	0	0
Chequer plts.				10	5	0
Angles				7	12	6
Tees				8	12	6
Joists				7	12	6
Rounds and squares 3 in. to 5½ ins.				7	15	0
Rounds under 3 in. to ⅜ in. (Untested)				8	0	0
				and upwards		
Flats, over 5 in. wide and up				9	2	6
Flats, 5in. to 1½in.				8	2	6
Rails, heavy				8	2	6
Fishplates				12	10	0
Hoops (Staffs.)				10	10	0
Black sheets, 24g.				10	7	6
Galv. cor. shts, 24g.				14	0	0
Galv. fencing wire 8g. plain				12	10	0
Billets, soft	6 0 0 to 7			0	0	
Billets, hard				8	2	6
Sheet bars	5 12 6 to 5			15	0	
Tin bars d/d	5 12 6 to 5			15	0	

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	2 1/4
Sheet to 10 w.g.	1	2 3/4
Wire	1	3 1/2
Rods	1	2 3/4
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	17.25
Basic	20.00
Bessemer	20.26
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.30
Sheets, black, No. 24	3.00
Sheets, galv., No. 24	3.85
Sheets, blue an'l'd, 9 & 10	2.25
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.25
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham & North.	
,, foundry	—
,, furnace	14/- to 15/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20 × 14, box	18/3
,,	28 × 20, ,,	36/6
,,	20 × 10, ,,	—
,,	18¾ × 14, ,,	—
C.W.	20 × 14, ,,	17/-
,,	28 × 20, ,,	—
,,	20 × 10, ,,	—
,,	18¾ × 14, ,,	—

Terneplates 28 × 20, — per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£18/10 to £19/0
Rolled Ord.	£15/0/0 to £15/10
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to £6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings
Gas ..	67½% ..	45%
Water ..	63⅓% ..	40%
Steam ..	60% ..	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
Sept. 1	54	12	6	dec. 6/3
,, 2	54	12	6	No change
,, 5	54	15	0	inc. 2/6
,, 6	54	13	9	dec. 1/3
,, 7	54	13	9	No change

Electrolytic Copper.

	£	s.	d.	
Sept. 1	62	0	0	No change
,, 2	62	0	0	,, ,,
,, 5	62	0	0	,, ,,
,, 6	62	0	0	,, ,,
,, 7	62	0	0	,, ,,

Standard Tin (Cash).

	£	s.	d.	
Sept. 1	288	5	0	dec. 25/-
,, 2	289	0	0	inc. 15/-
,, 5	289	10	0	,, 10/-
,, 6	290	0	0	,, 10/-
,, 7	290	10	0	,, 10/-

Tin (English ingots).

	£	s.	d.	
Sept. 1	286	5	0	dec. 15/-
,, 2	287	5	0	inc. 20/-
,, 5	287	15	0	,, 10/-
,, 6	288	0	0	,, 5/-
,, 7	288	0	0	No change

Zinc Sheets (English).

	£	s.	d.	
Sept. 1	36	0	0	No change
,, 2	36	0	0	,, ,,
,, 5	36	0	0	,, ,,
,, 6	36	0	0	,, ,,
,, 7	36	0	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
Sept. 1	27	5	0	dec. 8/9
,, 2	27	6	3	inc. 1/3
,, 5	27	12	6	,, 6/3
,, 6	27	10	0	dec. 2/6
,, 7	27	11	3	inc. 1/3

Lead (English).

	£	s.	d.	
Sept. 1	23	15	0	dec. 5/-
,, 2	23	15	0	No change
,, 5	23	5	0	dec. 10/-
,, 6	23	10	0	inc. 5/-
,, 7	23	10	0	No change

AVERAGE PRICES OF STEEL RAILS.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	£ s. d	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908	6 2 6	6 0 0	6 0 0	5 15 6	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 10 0	5 16 3
1909	5 5 0	5 5 0	5 5 0	5 0 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0
1910	5 5 0	5 7 6	5 7 6	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 8 11½
1911	5 15 0	5 15 0	5 15 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 13 1½
1912	5 13 1	5 15 0	5 15 0	5 15 7	6 1 6	6 6 3	6 7 6	6 8 0	6 11 3	6 12 6	6 12 6	6 13 9	6 4 4
1913	6 15 0	6 14 4½	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 10 0	6 10 0	6 10 0	6 10 0	6 12 0
1914	6 10 0	6 10 0	6 6 3	6 0 0	6 0 0	6 0 0	5 14 0	6 2 6	6 13 9	6 12 0	6 7 6	6 7 6	6 5 3½
1915	6 10 6	6 17 6	7 5 0	7 12 6	7 12 6	7 17 6	8 17 6	9 2 6	9 2 6	9 2 6	9 7 6	10 10 6	8 6 6½
1916	10 19 4	11 0 0	11 0 0	10 18 9	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 9 10
1917	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1918	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1919	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	17 5 0	14 12 11
1920	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	23 0 0	24 0 0	25 0 0	25 0 0	26 0 0	25 0 0	25 0 0	22 18 11½
1921	23 5 0	20 4 0	18 7 6	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	—	—	—	—	—

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE AT MIDDLESBROUGH.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1915	83 11	88 6	94 8	107 0	102 6	101 3	98 9	98 7½	96 6	104 0	124 1	130 0	106 11½
1916	133 9	140 0	136 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	128 1½
1917	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1918	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90 0	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	—	—	—	—	—

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